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This seminar was organized to bring together university staff members and students from agriculture, forestry, veterinary medicine, natural science and several areas of the social sciences interested in and knowledgeable about Indonesia. In two days of talks and discussion, a considerable amount of information was brought forth and concern expressed about the present status and future potential of agriculture and rural development in Indonesia. A keener awareness of the rural problems of this nation became evident during the course of interactive discussions between participating natural and social scientists. The presentations of written papers and taped discussion sessions at this seminar have been compiled and are hereby presented in the following proceedings.

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WELCOME AND INTRODUCTION

Kirk Lawton
International Studies and Programs
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Welcome to Michigan State University . . . it's a pleasure to have representatives from about a dozen universities on hand as resource persons for this seminar on Indonesian Agricultural/Rural Development.

I think it would be useful to give a bit of background on developments leading up to the seminar and who is sponsoring and underwriting it. Since 1970, the Midwest Universities Consortium for International Activities has had a technical assistance contract with the Agency for International Development to assist Indonesia to develop and improve its system of higher agricultural education. In this respect we are working with a consortium of Indonesian universities and faculties. Staff from the Universities of Illinois, Minnesota, Wisconsin, Michigan State (and to a minor extent the University of Indiana) have participated in long and short term assignments to the two major educational institutions in Indonesia responsible for undergraduate and graduate education in agriculture and related fields. Indirectly, this program touches all the government-funded universities . . . in Java and the outer islands.

One of the goals of this project is to build into each of the MUCIA universities a greater knowledge and understanding of Indonesia, the agriculture of the country, and problems relating to rural development. From the technical standpoint, MSU has about a dozen staff who have gained experience in the agricultural, forestry, and veterinary medical fields over the last five years. In contrast, we have relatively few faculty members with an up-to-date or on-the-spot knowledge of the Indonesian political and economic scene and of social/cultural restraints to rural development.

Last spring the MUCIA Board encouraged the organization of a series of seminars on the broad issues of Indonesian agricultural/rural development to be held at each of its member institutions and set aside some funds to carry them out. After some committee deliberations, it was decided to hold a 2 or 3 day conference in which scholars from the social sciences and agricultural sciences could present their views and exchange ideas and concerns on critical issues facing Indonesian agriculture and rural areas.

This seminar at MSU is the first of the series. Similar meetings will be held at Illinois in the winter of 1975, at Minnesota in the fall of 1976, and at Wisconsin in the winter of 1976. Many of you are aware that the University of Wisconsin held a conference on this same area of interest last July. In fact, some of the speakers for that program are here today. There are undoubtedly subject areas which are missing from our program, but we can accommodate only a limited participation in a two-day period. Purposely we have tried to involve the majority of our MSU faculty members who have recently studied or worked in Indonesia in the agricultural or rural sector. Sponsorship of the seminar on campus is by the Asian Studies Center, the Institute of International Agriculture, and International Studies and Programs. Needless to say, we look forward to some fruitful discussions during the seminar ahead.

In developing the program, we found it rather difficult to find some one person who has a firm grasp on a comprehensive and critical evaluation of the current political, economic, and social situation in Indonesia. We were unable to fill this slot, and I certainly am not qualified to do this. Instead, I am going to make some observations and statements which, during the course of our discussions, any of you can challenge, reinforce, or refute. I merely present them as a backdrop for your consideration.

Indonesia as a country has been in a rather continuous state of turmoil and growth for almost the past 35 years. It is a nation of contrasts in many ways. Population pressures on the island of Java and Bali are tremendous, while much of Sumatra, Kalimantan, Sulawesi, and West Irian are still unsettled. Efforts to relieve this situation have brought little relief. For example, transmigration projects to move people from Java to outer islands have been relatively unsuccessful. Government-sponsored family planning efforts have been expanding in the past five years, but any measureable reduction of population trends has yet to be proved. Migration from rural areas to city centers continues to be high. Unemployment and underemployment in both rural and urban sectors are very high by western standards during most of the year. Some parts of Jakarta and the larger cities look prosperous, but the major parts of these centers look depressed to outsiders. Rural poverty is evident even in the more fertile regions of Java. Inflation is again on the move. There is a great disparity between the incomes of the masses and the relatively few well-to-do in business

and government. Political opposition to the Soeharto regime has been rather effectively curbed. Military appointees fill most of the administrative positions involving political control of the country. There is a festering concern in the outer islands that Java is getting too great a share of the national resources, much of which come from outside Java.

Severe communication problems exist between the islands, and the power generation system within the nation cannot possibly meet the effective demand for years to come. A general upgrading of the primary and secondary educational system has been next to impossible because of the large annual increase in number of school-age children. Abundant man and woman-power are on hand, but the proportion of skilled to unskilled workers is very low. Corruption at many levels of government has been uncovered, but remedial measures to combat it have been only half-hearted. Massive government-organized schemes to rapidly expand rice production have met with many severe logistical problems and recent attempts to establish a national rice stockpile were less than successful.

However, considering all this, when viewed against the dark days of the middle 1960's, I would say the nation is substantially better off than it was 10 years ago. The national political and economic picture is a fairly stable one with very considerable investments of foreign capital since 1968. Revenues from international sales of oil should enable the government to greatly expand its social services and development plans. Until recently, inflation was rather well in hand. Many goods and services are now available, at least in urban areas, to the average citizen. The number of professionals is growing slowly. Attempts to reduce the civil service overload have been partially successful and salaries of government employees have risen proportionately. The physical infrastructure of Java has improved and to a lesser extent the outer islands. The main roads, harbors, airline services, telecommunications, bridges, etc., have been upgraded. In the first Repelita (5 year development plan) agricultural development received the highest priority. Plans for the second five year plan call for a focus on social improvements, primary and secondary education, and rural development. Except in the poor crop year of 1972/73, production of rice country-wise has been increasing. Substantial improvements and repairs have been made in water storage reservoirs and irrigation canals and water is now being made available on Java to areas not formerly receiving water in the dry season. Even plantation management

is improving as Indonesians acquire more experience and knowledge of management.

Yet for all this, the urban sector appears to have benefited most, while rural Indonesia which contains about 75 percent of the population and produces most of the food for the nation seems to be in a condition which might be termed "stagflation". I hope that in the next two days this seminar will look critically at the problems and potentials connected with agricultural/rural development in Indonesia.

POLITICAL AND ECONOMIC PROBLEMS OF INDONESIA
AS VIEWED FROM THE PERSPECTIVE OF THE BALINESE FARMER

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Last July, at the age of 35, I. Gusti Ngurah Ketut Muglong, a work-hardened, reserved, and direct-spoken Balinese, was elected klian dinas (elder) of the village of Wanayu located some eight kilometers northwest of Gianjar, seat of authority for Gianjar Regency. His neighbors evidently judged him a good farmer, but the honor also imposed responsibilities and he hardly can spare time from his efforts to secure his family's survival.

The klian dinas' farming activities are so dispersed much effort is lost. Reached only by a difficult path nearly four kilometers from the mud brick-walled courtyard of his home in the village lie the 25 are (one are equals 100 square meters or approximately 1,000 square feet) of sawah, or irrigated rice field, he owns. On this equivalent of slightly more than one-half an acre he receives an average of 300 kilograms (one kilo equals 2.2 pounds) of bras, or white milled rice, per crop net after the harvesters are given their traditional one-sixth share plus free meals. These yields are achieved with an improved variety of rice, Gadis, he began planting seven years ago with seed provided by the kantor pertanian, or chief agricultural extension agent, of Gianjar. Gadis can be harvested three and one-half months after transplanting into the field rice seedlings that have been sprouted for one month in the seed bed. Were sufficient water available from Subak Kedangan, the irrigation cooperative to which he belongs, it would be possible to grow three crops of Gadis annually. This summer a drought has affected much of Indonesia, including Bali, however, and even in normal years subak (irrigation cooperative) members are fortunate when water in their canals is adequate for two rice crops.

Nearly one kilometer from his house, also irrigated by the waters of Subak Kedangan, the klian dinas rents another 25 are of sawah. At the insistence of the

landowner, this field is planted to Bangawan, a variety of rice introduced here in 1958 from the Bogor Experiment Station in Java. Like most indigenous Balinese varieties, it is also almost nonphotosensitive and so can be planted at any time of the year and ripens in about 165 days. It does have the disadvantages of most Indica rice varieties; the stalk grows tall - up to one and one-third meters (one meter equals 39.37 inches) or more in height when nitrogen is abundant - and has a tendency to lodge with the fallen grain rotting in the mud of the padi field. When the owner provides his promised 50 kilos of urea, which is supposed to contain about 46 percent nitrogen, our farmer expects here, too, to produce a net of 300 kilos of bras per crop after deducting the harvesters share. As a tenant, he pays 75 percent of this crop in rent. From the two crops that can be grown in most years, therefore, I. Gusti Ngurah Ketut Muglong expects to earn 150 kilos of rice for his family's consumption.

Renting another six are of dry land a little closer to his house, the klian dinas is able to grow yearly three crops of the white Katela sweet potato. With a yield of about 100 kilos (harvest weight) of sweet potatoes per are per crop he nets 900 kilos of sweet potatoes annually after delivering one-half the crop as rent to the landowner - the vines are important feed for his draft cow and one pig that he bought as a weanling aged two months for R1,000.00 (R400 equals U.S.\$1.00) and expects to sell when it is full grown. Other farm activities include tending four chickens, ten ducks, seven coconut trees in the village plus a few banana plants and fruit trees. When farm work and his new responsibilities as klian dinas allow, he goes out to look for odd jobs near the village or even in Gianjar and then may earn R120.00 to R150.00 for a day's labor.

Despite sustained hard work, the result is a skimpy family budget. Like many farm families here, the klian dinas, his wife, and their two sons and three daughters aged one to seven years, usually eat only plain or sweetened bread with their native coffee for breakfast. The two principal meals are eaten at noon and about six o'clock in the evening. The family consumes two kilos of rice daily, cooked with an equal quantity of sweet potatoes, absorbing all the rice they grow, after allowing for seed, and most of the sweet potatoes. Even though their annual rice intake of 104 kilos per capita is far below the prized Balinese goal of one-half a kilo each per day, it still is above the average for the island of 94 kilos a year per person. In addition to spiced pickles and small side dishes, the diet

occasionally is varied with fish and frogs caught in the canals or padi (rice) fields, vegetables like both the taro leaf and root and wild leaves that are collected and cooked, plus tropical fruits, such as the green nangka, or jackfruit, that grows sometimes two feet long and can be eaten as a vegetable cooked with coconut oil or ripe as a fruit.

Most immediate is the problem of a growing family that increasingly needs more of food and everything; the mother had tried family planning, but she now is pregnant again, apparently due to misunderstanding, embarrassment, and contradictory motives. The shortage of cash is chronic. So much must be paid for besides clothing, medicine, school supplies, and temple contributions. Annual land taxes on the 25 are they own are R450.00, plus a fluctuating contribution to maintain the Subak irrigation canals. Rental of the sprayer from the kantor pertanian costs \$25.00 per day plus the price of insecticides. Urea costs about R1,500.00 for a 50 kilo sack - no phosphate nor potash is readily available commercially - and the yellowing leaves of the young rice plants in many fields are grim reminders of fertilizer deficiencies. "Every year I find myself more in debt," the klian dinas explains, with resignation. At present, he owes R25,000.00 borrowed from friends on which he is obligated to pay 5 percent interest per month.

Crucible of Balinese Culture

The emerald island of Bali lies eight to nine degrees south of the equator at the southeast fringe of Asia's predominately wet monsoon climate belt. Though today it seems uncommonly peaceful, its geologic past has been rent with massive volcanic eruptions from a number of mountain peaks which laid down immense deposits of tuff and ash. Gianjar, the site for this discussion, is located midway between the southern plain of the island and Mt. Agung, the still-active volcanic giant that runs up to 10,308 feet above sea level. It is here around Gianjar that one can dramatically see the all-important role of wet rice cultivation in making possible most of Asia's great civilizations. Incredibly beautiful scenes unfold with green padi fields forming giant steps as one looks from the sea upward to the mountain slopes.

Just when wet rice cultivation reached Bali remains for archaeologists and botanists to determine. It appears to have been practiced here during the first millenium of the Christian era and may have been brought from mainland Southeast Asia during the great migrations into the Pacific Island world. Elsewhere throughout this region available evidence suggests that construction of diked and

especially irrigated padi fields for rice cultivation, excepting tilling of swamps and seasonally flooded river basins, was a second stage in settled agriculture. Padi field construction followed after the tropical rain forest had been cleared by shifting slash and burn, or swidden, cultivators. And it necessitated sufficient concentrations of population to provide both labor for such costly construction and the demand for its produce. As the late pioneer geographer of Southeast Asia, Robert Pendleton, explained to this writer nearly a quarter century ago, wet rice cultivation in diked padi fields was the only form of traditional agriculture that halted the otherwise rapid erosion of fertility through action of high heat and humidity on most tropical and often lateritic soils.

While fertility carried down onto the padi fields from slopes above in the irrigation water was helpful in selected settings such as Bali, far more consequential was the new microenvironment created in a flooded padi field. Particularly on the more acid soils, the pH was raised, thus "unlocking" more mineral nutrients for plant use. Given the primitive plows, harrows, and other farm implements available then and still in use throughout most of Asia, a flooded padi field facilitated through "puddling" a quality of soil preparation that would have been impossible with dry fields. Weeds could be more effectively controlled both at the time of tillage and because of the "head-start" achieved by rice seedlings transplanted by hand from the seed bed aged three to four weeks or older. Once they appeared, it was also easier to pull weeds from a flooded padi field. And some algae forming a scum in the padi fields fixed nitrogen from the air in the water for plant absorption. Hence, at a time when crop failures elsewhere on this planet periodically prompted widespread famine and death, wet rice cultivation provided predictable yields fostering growth of population and immense civilizations in classical Asia.

The extent to which this ever more intensive system of farming was applied in "Inner Indonesia", namely Java and Bali, was perceptively documented by Clifford Geertz in Agricultural Involution. (1) From the early nineteenth through the middle twentieth centuries the elastic capacity of wet rice cultivation to absorb productively increasing applications of labor in further refinement of padi field farming astounded officials and scholars who observed this process. Dutch administrators expedited the development through construction of roads and rudimentary improvement of irrigation systems, notably as cement became available for building

dams, siphons, water control gates, and numerous other installations. Much of Java and Bali, however, enjoyed an advantage rarely matched elsewhere in Asia; most rivers bring irrigation water fed from alkaline volcanic debris. The rich mix of nutrients these streams carried to the padi fields made possible an intensity of farming and population sustenance that only the great alluvial flood plains on the Asian mainland could naturally approximate.

By a curious combination of favorable setting and accumulated skills, Bali came to possess another advantage; on this enclave of Hindu civilization in otherwise predominantly Moslem Indonesia her farmers evolved practices making them extraordinarily accomplished by traditional Asian peasant standards. Varieties of rice selected were largely nonphotosensitive, permitting planting and harvesting at all seasons of the year. This is in contrast to most of Asia where photosensitivity of rice varieties regulated flowering of the plant and locked farming into seasonal cycles and greater vulnerability to fluctuating rainfall. The subak irrigation cooperatives encouraged a quality of popular participation in the vital maintenance of canals that so often has lapsed elsewhere when central authority disintegrated. This led to better field preparation and weed control of the growing crops. Rotation to farmers of water supplied through subak canals also may have compelled them over centuries to select rice plant types that were least photosensitive.

Man Versus Land

Despite these exceptional advantages, time is running out for Bali and her gifted, attractive people. Ironically, the very quality and profuseness of artistic expression that pervades the society and is evident in their dances and drama, their carving not yet all cheapened and stereotyped for tourists, their weaving and painting and the grace of ordinary activity tend to mask the harsh facts beneath. Willard A. Hanna in Too Many Balinese (2) and Bali: Population and Rice, (3) has provided a detailed account of the demographic dilemma confronting this 5,600 square kilometer (2,147 square miles), lush and lovely island. A Dutch colonial census of 1930 counted a population of 1,101,393. Today the Balinese total over 2.2 million. That their numbers have only doubled during four decades is no cause for complacency; present rate of increase is calculated at 2.7 percent annually. A crude death rate of 18-20/1,000 and infant mortality (birth to one year) estimated at well over 100/1,000 can both be expected to

decline as modern medicine and drugs become more available. Even the considerable efforts at family planning now initiated through maternal and child care clinics imply protecting more effectively the health of the children now living.

Balinese farmers are affected critically by the fact that the present area of sawah, or irrigated rice padi land, totaling about 96,000 hectares is only slightly larger than it was in 1930, judging by available accounts. As Hanna has reported, this is due partly to the 1963 eruption of Mount Agung, covering more than 7,000 hectares of sawah and nearly ten times that area of dry land with volcanic debris. At great effort and cost this area is being reclaimed. More crucial is the shortage of water - only 68 percent of the sawah now receives enough water to raise a second crop of rice. Even the rice seed multiplication station at Pegok outside of Denpasar can secure irrigation water for a second crop of urgently needed new varieties of rice on barely one-half of its ten hectares of fields. The customary irrigation systems, superb for the time when they were constructed, even with the improvements that followed the coming of Dutch administration in 1908, are now inadequate. Nearly all are constructed as "run of the stream" diversion dams; although the mountain sides are sculptured into innumerable deep ravines almost none of these have been dammed to provide storage capacity for the dry season months from late April through October. Because of the intricate system of jealously guarded water distribution between subaks and within each irrigation cooperative, numerous small canals parallel each other, wasting both water and land.

Springs that flow year-around at numerous points, usually below the lower escarpment on the island's profile, hint at the water resources within the mountains behind. Since many of these springs are too low to feed readily into the irrigation canals, the water they discharge is underutilized. Most promising of resources, never significantly tapped for irrigation, appears to be the underground water table that is recharged annually from the heavier rainfall around the mountain tops where yearly precipitation frequently totals two and one-half to three meters. No survey of these resources has ever been made and Bali has no specialists in underground water geology, although Australian technicians working under the Colombo Plan are now identifying strata that promise potable water for the city of Denpasar and the growing demands of the tourist hotels. A cursory check of wells on the island indicates water at a depth of three to 15 meters in most communities, with a draw-down of at most several meters during the dry season. While a detailed

survey is needed, a major underground potential lies dormant that could substantially improve irrigation and allow the main rice granary in south Bali to produce probably two and even three rice crops where now water is sufficient often only for one good crop. Until Bali's electrification is much improved, pumps could be diesel powered and with the low lift should prove economic both for supplementary irrigation when a drought, as this past summer, dries the canals and in some areas for permanent water supply.

During the past four decades as the population doubled and the shortage of water under control limited both extension of the sawah and more intensive rice cultivation on existing padis, Balinese farmers turned increasingly to cultivating marginal uplands. The 1969 figures suggest what has happened to the landscape. Upland rice - unirrigated - was planted on 13,758 hectares yielding about 1.3 tons of stalk padi per hectare on the average. Stalk padi includes a six- to eight-inch stem and results from harvesting with the ani ani, or curved thin blade, held between the fingers. Since the indigenous varieties of rice are nonshattering, grain usually is allowed to ripen fully in the field. Bound into sheaves, this stalk padi is dried and stored until needed in the lumbung, or family granary, perched on four stilts with high, rounded roofs of thatched rice straw. Dry stalk padi weighs about 16 percent more than unhusked threshed padi that contains only the grain. Per crop yields of harvested, undried stalk padi from sawah in 1969 averaged over three tons per hectare. Most rice still is milled by hand pounding with a wooden mortar and pestle, allowing about 50 percent recovery of bran from dried unhusked grain, padi, which is more nourishing than polished rice because it retains some of the bran. This compares with about a 68 percent recovery of milled, polished rice from a few of the newly installed Japanese-made rubber-rollered huller mills that are operated properly.

Acreages and yields of other dry land crops also are suggestive of the great scope for improvement. In 1969, 46,513 hectares were planted to corn and yielded an average of 1.1 tons per hectare. Cassava grown on 21,281 hectares produced only some eight tons per hectare wet weight and sweet potatoes a mere ten tons per hectare on 22,729 hectares. Peanuts yielded roughly two tons per hectare (harvest weight) on 2,650 hectares and soya beans three-quarters of a ton per hectare on 12,491 hectares. Coconuts had come to occupy 68,000 hectares, providing both oil and copra meal for cattle feed used in Bali and some 18,750 tons of copra

for export to Java - coconut yields are difficult to calculate since nuts frequently are harvested as needed at home or for festivals. Trees show little sign of rat protection, however, which often can increase production by 20 percent, and systematic fertilization rarely is practice .

As population pressures have become ever more insistent, Balinese farmers have steadily pushed their fields further up the unstable slopes; their need for food is compounded by the emotional commitment which, as they say, makes "land a second wife." Resulting consequences for the landscape and climate are dire. Corn and other annual crops often are grown on slopes where in a few years erosion will have washed out most of the top soil. In keeping with President Suharto's order, Udayana University in Denpasar recently joined in making a regional survey for development planning by officials in Jakarta. They found that present forest cover extends over only 14.8 percent of Bali. And this 82,880 hectares includes the 27,721 hectares devoted to coffee. Although, as Hanna has warned, all statistics must be tempered with caution, it is suggestive of the ecological process under way that the most recent previously available figures showed a total area two and one-half times larger devoted to forest reserve, ravines and wastelands, and coffee gardens. As the remaining forests become smaller, the rate of destruction also accelerates; skilled Balinese carvers require more wood for the images they sell to a growing tourist trade, cremations though now less elaborate require fuel as do the lime kilns proliferating in response to a construction boom for tourists. Balinese continue to look to the forests for leaves eaten as vegetables and bark used in their native medicines. Insufficient rainfall data is available to measure the extent to which desiccation of the mountains prompts droughts plaguing Balinese farmers and denying water for the subak irrigation canals. Scientists at Udayana University calculate that a doubling of the forest cover to include 30 percent of the island is required ecologically and to restore the earlier moisture pattern upon which the sawah and livelihood of the countryside are so dependent.

Village of Wanayu

Like most Balinese villages, Wanayu still emits a sense of tranquillity, despite the bemos, or small covered pickup-type motor vehicles, motor bicycles, and buses increasingly linking the community with the outside. The aerial tentacles of a huge waringin (banyan tree) reach down from the spreading branches

to mark the crossroads that form the main streets. Opening onto these and also the side lanes are the family compounds, each entered by a gate built of two mud-brick pillars surmounted by a rice straw thatch-roofed arch and raised on a threshold of stone steps. Gates and compound walls all serve to keep in or out livestock and poultry, depending upon to whom they belong, and afford a family-centered privacy focused upon small living pavilions and the little temple raised above the bare, packed earth, the latter roofed distinctively with the durable near black thatch of sugar palm fiber. Most activity slows during the heat of the early afternoon, yet an abundance of bamboo clumps, coconut palms, and luxuriant tropical fruit trees give the village from a distance the appearance of a cool forest grove silhouetted against the glimmering green of the flooded sawah.

Village economic life revolves around these surrounding padi fields. There is neither industry nor electricity. Woodcarving, weaving, and painting provide limited part-time employment. For the 810 inhabitants of Wanayu - 135 households, each with its family head - their living depends vitally upon the two irrigation cooperatives that are considered geographically part of the village. Some families do cultivate plots, both sawah and upland, elsewhere, and a few farmers residing in other villages also raise crops on land in Wanayu, this pattern and incidental comments by farmers suggest there is intense competition for use of any available land. In Wanayu, the two irrigation cooperatives are Subak Kedangan with canals bringing water to approximately 40 hectares of sawah and Subak Banjarmasin that covers a slightly larger area of padi fields. I. Gusti Ngurah Ketut, the venerable klian subak, or elected head of Subak Kedangan, has held his position since 1965. He had five years of elementary school education, served in the prewar Dutch Netherlands Indies Army and for 15 years before being elected klian subak held a low paid job in the public works department of the provincial government. On produce from the 70 are of sawah inherited from his father he has been raising a family of nine children and sending his eldest son to a technical school in Java. Before he was severely stricken with cancer this past summer, this broad-shouldered, vigorous, and gregarious man was a true community leader, pioneering for his own and neighbors' benefit the BIMAS, which is the government-sponsored program to demonstrate the new, short-stemmed, high yielding varieties of rice first developed at the International Rice Research Institute at Los Banos in the Philippines. Introduced into Indonesia with local names, the first two varieties were identified as BP-8 and BP-5 and followed now by locally bred

variants named Pelita I and Pelita II.

As the head of Subak Kedangan, I. Gusti Ngurah Ketut explained its role. The 40 hectares of sawah are cultivated by 107 farmers who own their fields and 30 tenants. He estimates that sawah within the Subak would sell for R6,000 to R8,000 per are, provided anyone were willing to sell, which is rarely the case except under duress. Annual land taxes on sawah average R25.00 per are - houses are tax exempt. Nine of the present owners acquired their fields of not over 30 are each during the land reform in 1960 - they had been former tenants of the hereditary Radja of Gianjar, the family headed by the present Indonesian Ambassador to Austria, Ide Anak Agung Gde Agung. While these former tenants usually paid the government bank which was to compensate the previous owner, inflation in Indonesia during the last years of the Sukarno era made the compensation for land less than realistic. The largest landowner within Subak Kedangan today holds his allowed legal maximum of seven hectares of sawah which he inherited - he has three sons and one daughter, so this property is expected to be fragmented within the next generation. The smallest owner holds seven and one-half are and rents another 25 are of sawah in a subak outside of Wanayu. Since he has three daughters and no sons, his neighbors do not feel too bad about this situation, explaining "they will all go out of the compound." This attitude reflects rural inheritance practices prevalent here. Land is passed only to sons, except among the very wealthy when daughters also may share, and sometimes the daughters of ordinary folk are given the equivalent of a dowry in cash, livestock, or other portables after marriage.

Last April when I first visited with I. Gusti Ngurah Ketut, the klian subak was harvesting and threshing his demonstration field of 30 are of sawah planted under the new BIMAS program to BP-5. The yield weighed out at 96 kilos of unhusked grain per are, which would weigh about 80 kilos when fully dried. This yield of eight tons of padi rice per hectare is indicative of what a Bali sawah can produce per crop, given excellent management, enough water, and the required amounts of fertilizer, insecticide, etc. Had the klian dinas whose yields and family budget are discussed at the beginning of this report been able to equal these yields, he would have had a per crop return from his 25 are of 840 kilos of bras, after deducting the one-sixth share for the harvesters. By proper machine-milling instead of hand-pounding, he could have increased by one-third this return of bras, allowing ample rice for his family to eat and some to sell. It is

illustrative of the great potential of their sawah that awaits the full application of the Balinese rice farmers' skills. On this basis Bali should be capable of bettering the predictable production of two-crop padi fields in the Philippines that with modern management and inputs yield sufficient rice to feed 40 persons per hectare at a per capita consumption of 170 kilos of rice annually.

Much has been made both by Indonesians and informed foreign observers of the poorer taste and other less attractive eating qualities of the new varieties of rice, especially BP-8 and BP-5. These were originally released by IRRI at Los Banos in the Philippines as IR-8 and IR-5 and subsequently have been succeeded by varieties with better eating qualities and comparable yield performance, such as IR-20, IR-22, and IR-24, that also require more expert management in the field. The marketplace remains a revealing indicator of popular preferences within the limits of available means. Although his rice was hand-milled at home and therefore not polished white, the klian subak sold his bras from BP-5 for R30.00 and R32.00 per kilo when the Bangawan variety that has the customarily esteemed taste brought farmers here R35.00 per kilo. A frequent comment among villagers discussing rice and the new varieties is: "BP-5 is good when cooked with sweet potatoes." Necessity compels many rural Balinese to mix their rice for cooking with the much less desirable sweet potatoes - economic status of a family is judged by the proportions of sweet potatoes and rice they blend together. Given the chronic and growing shortage of rice in Bali, the insistent desire to shift from eating partly sweet potatoes, cassava, and corn to a staple of unadulterated rice and the enhanced yield potential of the new varieties, the scorn of more prosperous purists for rice that is not identical with their customary preference critically inhibits support for the "green revolution."

Despite the demonstrated advantages of the new varieties and technology, the klian subak remains the only farmer in Wanayu Village who systematically applied the new BIMAS program - his son-in-law, I. Gusti Made Kenol, who farms 50 are, has just planted a trial plot of Pelita I, a new variety from Bogor. And now this respected village leader is so ill he cannot walk to the fields. Yet, possibly in part because he senses life's twilight approaching, he speaks with rare candor. "Our farmers must adopt the BIMAS for all of Bali to survive," the klian subak insisted. "There are so many problems. Farmers still don't understand these new methods. We don't have enough water. When the insects attack, we cannot stop them. Fertilizer. Where are farmers going to get fertilizer when they don't have money

to pay and the government loans are out of our reach? Still, the biggest problem is political. There is so much bad feeling between them that most of our farmers do not cooperate with each other as they need to for the program to work." Seldom mentioned today in any except intimate discussion, he was referring to the heritage of bitterness of the terrible bloodletting that followed during the months after the attempted communist coup in Indonesia in September 1965. Educated estimates place the loss of life on Bali at between 5 and 10 percent of the adult population. It was far more than a communist-anticommunist struggle; old feuds that had festered for years and even generations were settled in the night by violence and burning. Inequality in implementation of land reform was one focus of friction. An even more bitter issue was, and still is, the ancient curse of irrigation farming: stealing of water. Walk along the canals today and an alert villager usually can show you where one farmer is drawing off water in a volume and at a time beyond his stipulated allowance, leaving less or none for the man at the end of the ditch. As population pressures increased relative to farm yields in Bali, all of these forces became more explosive, until the human volcano erupted.

Rural Perceptions

The farmers of Wanayu Village readily agree that Bali now has far too many people and insufficient land, especially sawah. What they do not share is a consensus on the solution. Hanna, in his above cited Fieldstaff Reports, has given a careful account of Bali's population and the family planning program that is generating sufficient publicity to make it a subject of popular discussion among farmers. Hindu Balinese must surmount far fewer hurdles than Moslems to avail themselves of family planning services. Here, male dukuns, the native healers who are also spiritual advisors, often act as midwives and are so depicted in wood carvings. Unlike in many Moslem communities of Indonesia, Hinduism enables male doctors in Bali to insert the intrauterine devices that public health officials recommend for rural women. One of Bali's 216 Maternal and Child Health Clinics staffed by a nurse-midwife is located one and one-half kilometers outside of Wanayu in a neighboring community. No exact statistics are available, yet it appears doubtful that in Wanayu the number of acceptors among fertile women exceeds the 12 percent claimed for the island population as a whole.

More positive responses among younger men and women who are most interested in limiting their family sizes suggest education is vital; those who have gone to the city or to Java looking for jobs, read more, listen to radio programs, and think

ahead in a larger context. Some say they are delaying marriage because they want fewer children. The great majority of farmers and their wives in Wanayu, however, are responding to keener awareness of population pressure in ways that illustrate just how time-bound rural communities can be. Whereas formerly farmers here hoped for many sons and few daughters, now their desires are reversed. They explain that because of the small plots of sawah cultivated by most families it is not good anymore to divide the fields among many sons. Still, it is valuable to have at least several daughters. "They will marry out," one farmer said, "and then if we are sick or need money or help on the sawah we can depend on their husbands." While admitting that family planning is necessary for Bali, some farmers acknowledge they are "ashamed" to cooperate; children still give status as revealed by Balinese names which indicate an individual's order of birth in the family. Others fear having their wives fitted with an IUD. From fragments of information gleaned about the pill, they think it would be preferable even though more complicated to use. Curiously, the ancient Balinese taboo against twins among commoners that once led to some infant deaths no longer holds.

As men who look to the land for a living, farmers here talk about other places where they can find fields or make sawah. During the past year, ten families emigrated to Sulawesi and Sumatra from the desa which includes Wanayu and nine other villages. Many of their neighbors are waiting eagerly to learn how these pioneers make out in the sparsely populated Outer Islands before deciding whether to venture. Each year, recently, more than a hundred young men left this desa, with a population of 5,400, to serve in the Indonesian Armed Forces. When they return home, it often is temporary; travel has enlarged their horizons and alerted them to more attractive opportunities elsewhere. Aware of Bali's booming tourist industry, Wanayu families do not see it offering substantial opportunities for themselves and their children; even some vegetables for the hotels are being imported from Java when they could be grown on this Island.

Providing food and employment for the anticipated doubling of Bali's population by the end of this century must be accomplished chiefly in the countryside. Seeking an economic solution primarily through tourism promises to prove a tragic mirage that, as Hanna has explained, will doom this unique civilization - attempts at this already generate resentment among concerned Balinese. As it has for centuries, the sawah remains the key to Bali's economic future. Improved cultivation of the uplands, especially with fruit and other tree crops, also can

contribute substantially. It is a mistake to assume that this necessarily condemns Bali's farmers to a further and more restricted lot in a continuing process of agricultural involution. While their rice farms are miniscule by Western standards, the transformation of attitude and use of manpower and resources that many identify with industrialization can be achieved on the land and with sounder social results. Man does not need to be displaced from his familiar rural setting and shoved into an urban slum to master new skills, even though this was the prevalent pattern in Japan and the West. Herein lies the most consequential significance of the "green revolution" in the tropics that, while emphasizing rice, is including a growing number of other crops. Nature affords a modified greenhouse setting that with effective management can be almost as productive as the artificial ones created under glass in the temperate zones. Once this opportunity is realized and utilized, the emerging human prospects can look to a healthier and happier design of man's relationship to his environment.

- (1) Clifford Geertz, Agricultural Involution: The Process of Ecological Change in Indonesia, Berkeley, University of California Press, 1963.
- (2) Willard A. Hanna, Too Many Balinese (WAH-1-'72), Fieldstaff Reports, Southeast Asia Series, Vol. XX, No. 1, 1972
- (3) Willard A. Hanna, Bali: Population and Rice (WAH-4-'72) Fieldstaff Reports, Southeast Asia Series, Vol. XX, No. 4, 1972

RURAL DEVELOPMENT AND THE LOCAL POLITICAL PROCESS

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Beyond its scientific, technological, economic, and administrative aspects, rural development also has a political side. In assigning a priority to rural as opposed to other kinds of development and in formulating and implementing policies for agricultural change, governments must decide on what basis and to what extent to encourage the involvement of the masses of the population; these decisions will in turn affect the type, amount, and pace of change. Moreover, popular pressures, acting independently of governmental policies toward mass participation, may also have a powerful effect on development. While it is possible to stipulate a number of ideal-typical government-people relationships which bear on problems of rural development, four patterns or models seem particularly relevant to the experiences of recently post-colonial Asian and African countries in general, and Indonesia in particular. (See figure).

If government desires (A) to encourage the active participation of the populace in agricultural policy decisions, it may choose between two general models - (1) allowing individual and local views and demands to take shape by themselves through the unrestricted formation of interest groups and political parties; or (2) the more disciplined strategy of organizing, channeling, and mobilizing popular views from above through the creation of a centralized political party or national front. The first of these models, the liberal democratic, is now out of favor in most Asian and African countries. Its virtues, according to its few remaining defenders, are that it provides a maximum of reliable information about popular attitudes to government decision-makers and ensures a maximum of enthusiastic cooperation from a people who respect majority rule as the foundation of a legitimate political system. Its chief disadvantage, according to many critics, is that the freedoms which permit a variety of opinions, groups, and parties result not in coherent and consistent policy-making but in immobilism (no policy decisions) or chaos. Another school of critics argues that since formally democratic institutions informally assume the shape of traditionally hierarchical systems of social stratification in most Asian and African societies, little

information or enthusiasm is generated at the village level despite the appearance of democracy.

The second, mobilizational, model is usually associated with the communist countries of the underdeveloped world - China, North Korea, North Vietnam, and Cuba - but has also been attempted elsewhere - Ghana, Guinea, Tanzania, Burma. Its main advantage is its capacity to transform man's traditional attitudes concerning his relationship to his fellow men and to his physical environment, making possible massive and rapid rural change. Successful mobilization requires heavy investments in organization, ideology, and perhaps coercion. In underpowered mobilization systems locally influential groups and individuals can find many ways to circumvent or undermine government development programs, often without the knowledge of the central leadership.

Government may also choose (B) to discourage popular participation, either (3) because it prefers a colonial-style technocratic and administrative approach in which the rural population is the object of development but is accorded no decision-making role or (4) in conjunction with a deliberate or de facto laissez-faire development policy which requires no continuing collective decision-making processes. In the former case, the intent is to clear the lines of communication from top to bottom so that the policy decisions of the experts reach the villagers in as undiluted form as possible. If the government's programs happen to fit popular sentiments, or alternatively if government has sufficient legitimacy or coercive power, this model may lead to successful development; if not, some form of resistance is likely.

Finally, model (B4), autonomous rural development, may be deliberately chosen in societies where limited government is preferred, or it may be the result of a government's minimal capacity to create bureaucratic structures sufficiently coherent and purposive to carry out at the local level centrally-determined development policies. In one sense, popular participation is irrelevant to this model, for there are no policy decisions to be influenced. In the longer run, however, the failure of self-generated rural development combined with a repressive government policy toward popular participation may lead to serious unrest.

All four of these ideal typical models of relationships between government and popular participation are potentially useful in understanding the Indonesian experience with rural development. In the 1950s Indonesia experimented with liberal

democracy. A multi-party system which divided rural villagers as well as urban elites along religious, class, and ethnic lines was unable to resolve conflicts or create a political process conducive to planned agricultural development in the short time it was in operation, but whether the fault lay primarily in the party system, the newness of democratic institutions, or the dissatisfaction of powerful extra-parliamentary forces (i.e., President Sukarno and the army) is still in dispute.

Especially at the beginning, President Sukarno's Guided Democracy (1959-1965) was thought to be a mobilization system along the lines of Kwame Nkrumah's Ghana or Nasser's Egypt. But the only significant mobilization in this period was the work of the communist party, much of it directed against the government and the local elites seeking to preserve their positions, status, and wealth through government protection. Aside from communist activity, Guided Democracy at the local level more nearly approximated the de facto autonomous than the mobilization model, for government had neither the will nor the capacity to organize effectively the rural population for development.

Since 1966 Indonesia has been ruled by the New Order of President Suharto. Although there were some early attempts to create a true mobilization system with domestic development as its primary objective, by 1969 the regime had chosen the administrative model. How successful this policy has been is unclear. The mixed record of successes and failures in the agricultural sector may be attributed to poor programs and inefficient administration, in which case improvements can be made relatively easily. On the other hand, the problems may lie in a politicized administration (in the sense not of partisan politics but of competing civilian and military hierarchies, of cliques within those hierarchies, and of individuals using official position primarily for personal gain or advantage), indicating that the New Order most closely resembles not the administrative-technocratic but the de facto autonomous model. If the latter, Indonesian agriculture may be thrown back on its own resources, dependent on the capacity of individual farmers to seize economic opportunities. A combination of official discouragement of popular participation and rural economic stagnation may in turn lead to a new cycle of popular pressure for fundamental political change.

FIGURE. Popular Participation and Rural Development

	A. Government Encourages Participation		B. Government Discourages Participation	
	1. Liberal Democracy	2. Mobilization System	3. Administrative-Technocratic Model	4. Autonomous Development
Possible consequences of participation for govt.-sponsored rural development	supportive resistant	supportive resistant	irrelevant resistant	irrelevant resistant

PROBLEMS OF SUCCESSFUL INNOVATION:
A CASE STUDY OF A WEST SUMATRAN VILLAGE

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Introduction

Problems associated with achieving a successful agricultural innovation can be broadly grouped into four categories:

1. Discovery/Invention. Under this heading are located all the problems of finding or making or developing new seed, right fertilizer foses, new machinery, etc., that have the necessary technical and economic characteristics to be profitably adopted and practiced.

2. Institutional Framework for Implementation. Here belong all the problems of building the institutions necessary for particular innovations to be successfully implemented - extension service, testing plots, fertilizer distribution network, credit arrangements, marketing outlets, etc.

3. Acceptance. All the pitfalls and troubles of getting farmers and communities to try new inputs and methods fall under this category.

4. Consequences. Besides the desired increase in agricultural output, all sorts of other economic, cultural, social, psychological effects result from an agricultural innovation. Many of these consequences are often undesirable. For example, the mass removal of tenant farmers in India or the breakdown in the community harvesting patterns on Java.

Before an agricultural innovation can or should be labelled successful, the problems of all four categories must be overcome. Often there is a tendency to acclaim success after the problems of the first three groups are met and agricultural production increases. However, if this increase causes problems that do more harm than good, how can it be called successful?

Of course, there are relations and interdependencies between the various problem categories. For example, the characteristics of the change will be a factor in determining the supporting institutions needed and methods of introduction to be used. Or the overcoming of some disastrous side-effect may require a seed with different properties or different support arrangements for credit-

granting or another way of introducing in order to reach small farmers.

What impact a particular change is going to have obviously depends on such factors as its technical and economic characteristics, the arrangements and practices of the supporting institutions, the methods of introduction, the economic relationships existing in the recipient village, and the whole social, cultural, political setting in which the change takes place. The first three variables can be examined or designed in the laboratory or the planning room and can be considered as applying everywhere in a country. However, the last two deal with conditions as they exist in villages and generally will be unique from area to area, even from village to village. Hence, in order to know if a particular innovation is going to be successful or to make it so, there is a need for field investigations.

This paper is a case study under the category of consequences. It deals with the economic impact of the introduction of new high yielding rice varieties, chemical fertilizers and pesticides in a village in Indonesia. It examines the total, village-wide impact on absolute and relative income distributions. Remaining parts of this paper touch on the theoretic framework of transmission of the gains and losses throughout the village, the actual results of the case study village, and some concluding remarks on the applicability of this single experience for Indonesia in general.

The Framework

The economic impact of an innovation can be divided into two components: the direct, immediate impact that comes upon the adoption and successful implementation of new inputs and/or methods and is experienced by the participating farmers and the indirect impact that works its way from the adopting farmers to others in the village through a number of linkages. Since villages are not composed of homogeneous peasant farmers, but instead consists of all sorts of different social and economic groups, as well as individuals, who vary in abilities and enterprise, the effect of a change will not be the same for all.

The linkages through which the impact of a change is transmitted can be classified into the following categories:

1. through inputs - land, labor, credit, etc.
2. through output - processing, storing, marketing, transporting, etc.
3. through the use of increased income - for what, consumption or saving;

from where, local or outside, etc.

4. through technical spillovers - dead ducks, etc.
5. through government actions - taxes, expenditures, regulations, etc.
6. through transfers that are based on non-economic reasons - marriage ceremonies, religious contributions, obligations to relatives, etc.
7. through common markets - for inputs, outputs, desired goods, etc.

The linkages that connect participating farmers with others, also connect others with still others, as well as to each other and back to the original farmers, so there is a multiplier effect throughout the village.

The Case Study Village

Background

Since it is impossible from merely an examination of the technical and economic characteristics of a particular innovation to know what its impact in a village will be, the author undertook a case study field investigation of the economic consequences of the adoption of the new high-yielding rice varieties, chemical fertilizers and pesticides in a village in West Sumatra, Indonesia. Through direct observation, specific studies, and a random sample of 99 households, the direct and indirect effects through the various linkages were examined. The selected households were interviewed by university students twice in a course of a year, after each growing season. While the basic interviewing was done in one setting, as many as four revisits were done to purify and balance the information received.

The chosen village is located in the eastern part of the province in the upper end of a valley. A major river cuts through the village land and several streams provide water adequate for rice growing during most of the year. The village contains around 2,000 people in roughly 300 households. It is a Minangkabau village which is famous for being matrilineal.

The major products of the village are rice and rubber which account for roughly 40 and 16 percent of the total net income of the village respectively. About half of all income is in non-cash form and only nine percent originates from outside (mainly gifts, pensions, and government salaries), although the rubber and a significant portion of the rice are sold outside or to outsiders.

Rice cultivation is still done mainly by hand, although water buffalo or oxen are extensively used to prepare the fields. The planting pattern is a single transplanting one. Harvesting is done with a hand sickle. The only machines used

are a simple, hand-turned separator of the rice from the remaining bits of chaff and gasoline-engine-driven hullers to remove the hull and polish the rice.

About a third of the land is used for sharecropping and about a third of the farmers are sharecroppers. Generally a third of the gross production is paid to the landowner. The rest of the farmers operate their own lands, although this can vary from a situation in which the household itself provides all the labor used, to the other extreme where the owner assumes only a supervisory role and hires others to do all the various tasks. Wage labor is extensively used, especially in planting and harvesting. While there is a range of combinations of meals and wages, generally the laborer is provided two meals and paid in cash.

Extent of Adoption and Degree of Success

Table 1 shows the extent of adoption of the new high-yielding rice varieties and chemical fertilizers during one growing season. All but one of the sample households were using a new variety and all the households were using chemical fertilizers and to a reasonable level of dosage.

Table 2 lists the costs external to the households experienced by them during this season. Table 3 presents the summary of production, costs, and net income for that season. Production ran about three tons of milled rice per hectare. If the rupiah is valued at 415 to the U.S. dollar, the net income (return to the household's labor, land, and capital) ran about \$300 per hectare. Both these figures are good for Indonesia.

Table 4 compares the total production and yields per hectare per cropping expected before the use of the new seeds and chemicals with those expected now. The numbers presented are not actual experience, but rather the farmers were asked what they consider normal now and what they consider to have been normal before all these changes. The new varieties have a much shorter growing season than the older ones, making it now possible to crop twice in a year instead of only once as formerly done. Note that total production has increased by 293 percent. This increase can be broken down into several parts - to planting twice instead of once - area planted has increased by 112 percent - and part due to increased yields per cropping - 85 percent increase.

In Table 5 a comparison is presented of actual rice income and total net income of the village experienced in 1972/73 with a hypothetically reconstructed income from before the use of the new seeds and chemicals. Prices for 1972/73 were

used in the reconstruction so the figures are immediately comparable; no correction for price changes is needed. Also the reconstruction was done as if the population were the same, so there is no need for a per capita adjustment.

In reconstruction the "before" income, all incomes except those of producers of rice and the landowners who received a share of crop were kept constant. Rice production was reduced to the reported normal before the introduction of the new seeds and chemicals. The same rice price was used. The cost of credit, fertilizers, pesticides, and taxes, which were recently introduced, were eliminated from the costs. Processing and share-cropping costs were reduced proportionally to the reduction in rice production. Labor costs for only one season were included and this figure was reduced by the somewhat arbitrary, but defensible figure of 40 percent, to adjust both for the fact that the new methods are more labor intensive and wages have risen. Landowners' shares were reduced proportionally to the overall reduction in production.

As can be seen from Table 5 total gross rice income has increased by almost 200 percent. However, since costs have risen even faster, net income has gone up by only 140 percent. In terms of total village income the increase is 20 percent. All three of these figures understate the amount of increase, especially the one for the total net income. The 1972/73 year was not particularly good for a variety of reasons; the most important being drought and rats. The total net income needs adjustment to allow for the fact that the level of many of the other activities in the village depend on the rice income; for example, sales of stores, amount of transportation, house building.

Anyway, without doubt, the adoption of the new seeds and fertilizers has been practically universal and has been tremendously successful in increasing rice production and income. These increases have been substantial in terms of the village income. The absolute income level of the village has risen, but what about its relative distribution? How has this increase been shared?

Relative Income Distribution

Data in Table 6 are based on the actual experience of 1972/73 and the reconstructed "before" incomes provides an answer.

The Gini coefficient, which is a commonly used measure of inequality, shows little if any difference. It is doubtful if the difference is significant. If the distributions were to be graphed in a Lorenz curve form, the lines would

cross and be practically indistinguishable. There appears to have been overall no change in the relative income distribution. Of course, individual households may have experienced a sharp drop or rise in relative standings, although I suspect any such cases are rare.

TABLE 1

Number of Household Planting, Total and Average Hectares Planted, and the Amount of Fertilizer Used by Rice Variety in the 1972-73 Season.

Variety	Number of Households Planting	Hectares Planted		Kg. Fertilizer Used*		
		Total	Average	Total	Ave.per HH	Ave.per Ha
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1. Local	1	0.50	0.50	190	190	380
2. P. B. 5	13	2.47	0.19	1380	106	559
3. P. B. 8	68	22.02	0.32	9500	140	431
4. Pelita I/1	1	0.17	0.17	70	70	412
5. I. R. 20	9	2.95	0.33	1085	121	368
TOTAL	92	28.10**	0.31	12,225	133	435

* Urea and TSP. Calculated roughly from the total rupiah value.

** Does not add up because of rounding.

TABLE 2
Costs* of Rice Production for the 1972/73 Season

For What (1)	Number Households (2)	Cost in Rupiahs			
		Total (3)	Ave. per User (4)	Ave. Overall (5)	Ave. per ha. (6)
1. Credit	66	29,520	447	321	1,051
2. Labor from outside the household	91	1,690,985	18,582	18,380	60,177
3. Seed	92	92,340	1,004	1,004	3,286
4. Fertilizer and Insecticides	92	354,430	3,853	3,853	12,613
5. Other inputs	8	13,900	1,738	151	495
6. Share cropping	36	697,680	19,380	7,583	24,828
7. Taxes	69	44,690	648	486	1,590
8. Processing outside the household	91	123,170	1,353	1,339	4,383
9. Other costs	4	3,900	975	42	139
TOTAL	92	3,050,615**	--	33,159	108,562

* Not including use of the hold house's own time, land, and equipment.

** 64.6 percent of this total was paid in non-money form, i.e. meals, rice.

TABLE 3

Total Production, Costs and Net Income of
Rice for the 1972/73 Season

What (1)	Amount		
	Total (2)	Ave. per household (3)	Ave. per hectare (4)
1. Total Production in gantungs of paddy	115,408	1,254	4,107
in kg of milled rice equivalence	80,786	878	2,875
2. Value of Production* Rp	6,539,925	71,086	232,738
3. Total Costs Rp	3,050,615	33,159	108,563
4. Net Income (2-3)	3,489,310	37,927	124,175

* If sold, the rice is valued at the sale price; otherwise, one gantung of paddy equals 55 Rupiahs.

TABLE 4

Comparison of the "Normal" Rice Production and Yields of
Now with Those of Before the Use of
Chemical Fertilizers, Pesticides, and New Rice Varieties

What (1)	Before (2)	Now* (3)	Percentage Increase (4)
1. Area Planted Ha	28.02	59.38	112
2. Total Production in gantungs of paddy	64,920	255,100	293
in Kg of milled rice equivalence	45,444	178,570	
3. Yield/Ha/cropping in gantungs of paddy	2,317	4,296	85
in Kg of milled rice equivalence	1,622	3,007	

* Before, there was only one crop a year; now, there are two.

TABLE 5

Comparison of Rice Income and Total Income
For the Year of "Now" with "Before"

What (1):	Before* Rp (2)	Now Rp (3)	Percentage Increase (4)
1. Total Gross Rice Income	3,858,000**	11,332,000	194
2. Total costs	1,992,000	6,834,000	243
3. Total Net Rice Income	1,866,000	4,498,000	141
4. Total Net Income	15,454,000	18,521,000	20

* See the text for the methods and assumptions of calculation.

** All figures are in 1972/73 prices.

TABLE 6

Comparison of Relative Income Distribution Between "Now" and "Before"

By Whom (1)	Percent of Total Income Received	
	Before (2)	Now (3)
1. Top 5 percent	15.5	14.6
2. Top 10 percent	26.3	26.0
3. Top Fifth	42.0	42.1
4. Second Fifth	21.8	22.8
5. Middle Fifth	15.3	14.8
6. Fourth Fifth	12.4	12.1
7. Bottom Fifth	8.5	8.2
GINI COEFFICIENT	0.326	0.333

Applicability to Indonesia in General

This is a success story in about any way one wants to measure it. Rice production and income are up and the relative income distribution is no worse than before. In order to make any statement about the applicability of this experience to Indonesia in general, it is necessary to examine why the adoption was so universal and successful and why the income effects so proportional.

While one case does not prove or disprove reasons, it does allow speculation. The conditions seem favorable for successful adoptions in numerous ways:

- The village is open and receptive to objects and ideas from outside. There is a high level of education. Almost all the males have spent years outside the village. The villagers are used to having outsiders come in.

- The inputs are available. A German technical team has been working in the province since around 1967 training the extension service and building a network for credit and fertilizer distribution. Credit and fertilizer are readily available in the village.

- A marketing outlet exists. This part of West Sumatra is the rice bowl of two neighboring provinces.

- The physical conditions are suitable. There is water and water control.

Unfortunately, these conditions do not exist throughout Indonesia, sharply reducing the applicability of this case.

As for the favorable or at least lack of unfavorable effect on relative income distribution, the effect can be explained in terms of the Minangkabau societal rules on land. In this society every female descendent inherits from her mother an equal share of the mother's rice land. Or perhaps more accurately each woman inherits the user rights to an equal plot of rice lands. The land cannot be sold except under narrow, special conditions and then only with the permission of the head of the clan.

The result of these rules is that practically every family has some land. Since different branches of families and families grow at different rates, the land holdings are no way equal, but almost everyone has some. Plus those who do have more are under social pressure to share crop land out to those who have less. The end result is that access to land is even more equally shared.

Since the type of agricultural change considered here can be adopted on any size plot, and since almost everyone has access to land, it is not surprising

that everyone gained, generally in proportion to his earlier income.

Everyone having access to land is not common in Indonesia. On Java, for example, almost every village has a large proportion of landless laborers. So the favorable effect on relative income is unfortunately very restricted in its applicability.

The limited applicability of this case means that more field investigations are needed to determine what is happening. This is necessary in order to be able to offset the bad effects and encourage the good so that an agricultural innovation can be, in the fullest sense of the word, successful.

CONTRIBUTION OF AGRICULTURAL UNIVERSITIES AND FACULTIES

TO RURAL DEVELOPMENT

Alan M. Strout

Today I'm supposed to talk about the contribution of agricultural universities and faculties to rural development. I accepted Dr. Lawton's invitation to talk on this subject with some feeling of relief, since he had asked me originally to talk about the current economic status of Indonesia, about which I know very little. Thus I thought this topic was something I could talk about rather easily since I've just spent four years out in Indonesia telling everybody who cared to listen what was wrong with the system and trying to design better ways of training people to have greater impact on the rural development of Indonesia. I found that despite the fact that I felt I didn't really know what I was talking about, people listened to me with a great deal of respect and actually seemed to believe what I was saying, and even helped to get money to do the kind of things that seemed to be indicated.

In sitting back after my recent return from Indonesia, however, and contemplating this problem, I am becoming once again less and less sure of how much I really do know and how much can be said on the subject. This may be part of the cultural shock of a recent returnee, or it may be partly the fact that my sea freight hasn't arrived yet and I feel sort of lost and aimless without the security of stacks of files and books and references. But I think it's also a problem of definitions and of the reevaluation that's been going on generally of what really is meant by rural development. We need to consider what it is we're trying to achieve and what is the goal of societies like Indonesia. This concern has been brought home to us in the United States in recent years by the reevaluations that are going on in our own society, just on this perpetual increase kick. Should the developing countries be encouraged to seek for an ever-increasing amount of material good things of life at the sacrifice of many social or cultural relationships they now feel to be desirable?

Then you get into the political and social and other problems that we touched on this morning. One wonders if we really know what we're talking about. I made

a trip around to some American universities and colleges about a year and a half ago, talking to some of the social scientists, and trying to find out what really interesting and exciting work was going on in the social sciences with those fellows. The conclusion I came to was that there wasn't very much. There weren't very many people doing much or thinking very hard about these subjects.

Now let me confess to a couple of biases or limitations in what I am going to talk about. I've been working almost completely in the social sciences in Indonesia. I came to Indonesia from a sort of general background in economics with a bit of agricultural economics, and learned a little bit more while I was there. But I don't really know much about the physical science and natural science side of things. This is a limitation you should be aware of because it seems to me the problems are much more difficult in the social sciences. I feel that it's somehow easier, in spite of all the well-known difficulties, to develop new varieties, to figure what sorts of inputs are required, and perhaps even to design systems for getting the inputs to the cultivators. These systems should work if everybody behaved the way a rational person is expected to, but things haven't worked out this way, and it seems to me the real need for societies such as Indonesia is much more work emphasis on the social science sides of things. So these are my particular biases.

Now I should say just a few words about the educational system in Indonesia, assuming that you are probably not too up-to-date on the situation there. I don't want to spend too much time on it, and I will ask Mr. Kartomo and others who know something about it to think of the points that I may omit, because I haven't rehearsed and there are plenty of things that ought to be covered.

First of all, it's a system that is largely bounded by public institutions, and the hand of government is very strong. All of the respectable universities in the country, with one or two possible exceptions, are government-run institutions. Secondly, historically the system has been dominated very much by the Dutch, or I guess you could call it the older European influence. There tends to be a hierarchical arrangement within the university where the power and prestige goes to the older faculty members. There's a great deal of compartmentalization among faculties with almost no communication between faculties, at least in the sense of students going from one faculty to another or taking courses in faculties other than their own. There is also a tendency to get into a particular track, if you're

a student, and to have very little option about what you do thereafter. The better students are urged to come back and teach within their own faculties. If they're lucky, they go to the United States or some other country overseas to obtain another degree, and still come back to their own faculties. In fact, there are several reasons why graduating students get locked in very strong holds at their original schools. So, traditionally, there isn't a great deal of mobility and there isn't a great deal of flexibility within the system. This is changing now to some extent. The American influence has been a very strong and powerful one. During the period of 1957-66, the University of Kentucky had a big team at the agricultural university at Bogor. Now the MUCIA program has sort of taken over this institutional role, and I would say is making a very strong imprint on the ways of thinking about education. The result is, to some extent, a dichotomy pulling in different directions, with the younger generation somewhat more interested in the American system of education.

In terms of numbers, the intent around 1960 was to set up a public university in every region or province of the country. This would have given 23 or 24 faculties of agriculture. My impression is that it's not quite that large, but somewhere close to 20 or so universities that we're talking about which have agricultural faculties. On the other hand, the total number of students involved is quite small. Most of the universities will have only 2 or 3 thousand students in them. The largest ones will run 15 to 20 thousand for all faculties, but even there you run into only 2 or 3 thousand students in the several agricultural faculties. I believe the Institut Pertanian Bogor, which is the number one agricultural university in the country, has around 2,500 students. A few years back, as I recall, there were 95 thousand public university students in all of Indonesia, a country with a hundred and fifteen million people at the time. So this is really just a drop in the bucket. We shouldn't ignore the private universities completely because there are a great number of them. It is likely there are more students in private universities, I suspect, than there are in public universities. Not too much is known about their quality and a substantial number have a sort of fly-by-night status about them, in spite of the government's efforts to set some standards which would be applicable to all. The private universities serve mostly to take the overflow of candidates for college who find they are unable to get into the public universities and have the money to pay the somewhat higher fees at the

private schools. They also serve very effectively as devices for increasing the incomes of teachers in the public universities, since many such lecturers do have connections with one or more private institutions, where they teach in their off hours.

The other aspect I want to mention is the quality of education. Certainly within Indonesia there are enormous differences between the best universities and the poorest universities. The best university in the country when it comes to agriculture is the Institut Pertanian Bogor, which is usually translated Bogor Agricultural University. Gadjah Mada is number two, but it's somewhat below the school at Bogor in most respects, I would say. Also there are one or two other universities that are in a category somewhere between Gadjah Mada and the remainder which are not much more equivalent than technical schools. A few out in the remote areas of the outer islands are pretty far down.

This has given rise to a very interesting innovation in terms of improving the universities, namely, the Pembina system. The decision was made about ten years ago that if you only have scarce resources to improve your university systems, you should concentrate these on the better institutions, and then assign these better institutions a certain responsibility for improving the poorer institutions. I think this was a rational decision, and the better universities have been improving under this system. As might be expected there has been a great deal of resentment from the less well developed institutions, and political problems have been created by this. However, the situation has been modified, and I suspect as more money becomes available that it will be adjusted more.

One other aspect I didn't mention was the length and kinds of degrees offered at Indonesian universities. The pre-university training is not too different from what we're used to in America; ten or twelve years of primary and secondary school. The first university degree is supposed to be a three-year degree similar to the English or Dutch baccalaureate. It's known as the Sardjana muda degree after which you may then go on for another two years and get an engineering, science or arts degree which is supposed to be roughly equivalent to a master's degree in other countries or in the United States. In point of fact, almost no one who enters the system stops, at least intentionally, at the S.M. degree. The aspiration of every university student is to receive the Ir. or Drs. or Dra. degree. Of course, there are various economic and other problems in the way so it takes typically not five

years to reach this goal, but probably closer to seven or eight years. The students you see here in the United States who come overseas under government sponsorship all have one of these three degrees. There isn't a rigid government policy that they can't leave the country before receiving the advanced degree, but in fact that's the way the system pretty much works out. And most of them in fact will have had a couple of years teaching experience as well. This is one reason why graduate students who come to the U.S. tend to be considerably older than the American student.

Next I'll talk a bit about the accomplishments of this particular system. First of all, I was somewhat surprised at the figure given this morning of only about 2 percent of university students in agriculture coming from farming backgrounds. I would have guessed it was somewhat higher than that. Certainly if you broaden it to be rural background, where your relatives are farmers, I would guess the figure would be closer to 50 to 70% for the agricultural faculties. And my impression is that the students in the agricultural faculties do have a very strong sense of social service, that is, they seem to be genuinely interested in rural development, rural problems. There's a considerable emphasis on getting the students to spend about six months or more in a village or on a plantation or with the Forest Service as part of their training, usually while working on their 5th year thesis problem. This varies to some extent from university to university, but I do think there is probably a stronger feeling of social obligation and service in the agricultural faculties than possibly some other faculties. The students of Indonesia have taken an active role in the political upheavals that have taken place since independence; they were mobilized to help get the Green Revolution started in the country even before the new varieties were available. Teams of students and instructors from the universities at Bogor and Jogjakarta, working at the village level, came up with some really remarkable increases in yields in local action projects that gave rise to the BIMAS (National Accelerated Rice Production) program that was mentioned this morning. This national program, which started about 1970, was able to take advantage of some of the new varieties available by that time. The emphasis however has been pretty much in one direction, from the top downwards, bringing government-devised programs down to the farmers, rather than serving as communication links from the farmers up to the government.

The universities, I think, have also been very successful in the role that I expect they play everywhere of helping to inculcate a group of elitist types with sort of a standard set of values, with paths of communication among each other. Since most of the graduates go into government service, this probably has contributed to improved efficiency of the communication level within the government service. There has been, in a number of cases, a fairly activist leadership at the provincial level; this leadership has been successful in enlisting the help of the universities, to the point where the universities really provide the planning and intellectual staff for the governor and the governor's office. Of the 24 or so provinces in Indonesia, however, there are only about a half a dozen that I would characterize as having this kind of activist leadership. The economists and the agricultural economists have been at the forefront of this assistance in regional planning and programming. The places that are probably best known for this right now are West Sumatra (Andalas University), the northernmost part of Sumatra (Syah Kuala University), and South Sulawesi (Hasanuddin University), and then a much more confused situation in Java, where the universities have their greatest strength, but which also tends to be the area where the provincial leaders have much less autonomy and it's much more mixed up with the national politics and also peculiarities of Javanese character. But where they have been able to form successful teams, as particularly in Sumatra and South Sulawesi, I think there are some very real and very strong accomplishments from the point of view of assisting the government bureaucracy. I'm going to leave aside for the moment the whole question of assisting the farmers, and assisting rural society as I would like to define it.

The faculty members at the universities are doing quite a bit in the nuts and bolts type of work of preparing feasibility studies. This has been an essential ingredient in a lot of the foreign-aid money that is coming into the country. Foreign donors like to insist on a nice set of documents which indicate that everything has been thoroughly looked into, and Indonesian faculty members are willing to spend a good deal of time in such efforts. Such feasibility studies are also required for development money that is channeled through the Indonesian banking system. Survey work of this kind has provided an important secondary source of income for hard-pressed academics.

In Java there are also signs that the universities can play a very effective role, not necessarily at the provincial level, but at the sub-provincial level.

There is a lot of competition for resources that we heard referred to this morning among the sub-provincials and the sub-district level bureaucrats, and their close contacts with some of the universities, such as I.P.B. and Gadjah Mada generally are useful in the planning and bureaucratic process. The universities are not quite sure what to do; they're not quite sure what their tools really are, but at least they're getting people out working with and talking to the farmers. I think these are very real accomplishments, although I've sort of avoided the question of what really has been accomplished in terms of growth and rural development.

There are, I think, some very real weaknesses within the university system, and I'll discuss these for a minute. I'm going to characterize them in an oversimplified way, so that you'll remember it a bit easier, as a Triple A syndrome. The first A stands for authoritarianism. This is the tendency for students and young lecturers to be terribly respectful of their elders, particularly the Guru Besar, the big professor who may be the head of your department, and of not being willing to speak back to your professors in class if you're a student. Students aren't really encouraged very often to engage in discussion or questions within the classroom. However, this hierarchical, authoritarian system is changing in a very real sense. Exposure of young staff members to the educational process in Europe, the United States and Australia is partly responsible.

The second A is absenteeism, a problem which, I understand, occurs in many developing countries. The teachers simply don't get paid enough to commit them to spend too much time around the universities. They get paid a so-called basic salary which is about equal to a fourth of what they require for survival at sort of accepted standards of university teachers. As a consequence they spend around 10 to 12 hours a week on the average at the university, including three to four hours in the classroom and then not much more than four or five hours working with students' homework assignments, class preparation, and everything else. Now I think ten hours a week is probably a fairly conservative estimate of the time actually spent. This has been a complaint from the visiting professors there sponsored by MUCIA and it's been a complaint of the Indonesians who are trying to run faculties and departments. On any particular day, you may find only 10 to 15 percent of university staff actually "on seat". Well, it's very hard to create the kind of scholarly institution that depends heavily upon interaction between teachers and students, if you've got this part-time approach to education.

The third A is intellectual apathy. I was sort of looking for another word here that begins with A, because apathy is somewhat too strong and I don't want to overstate my case. What I mean is a lack of opportunity, possibly, or a lack of incentive to really come to grips on an intellectual level with the problems with which they're dealing, and a tendency to accept too readily and unquestioningly the teachings, either of their professors and their textbooks or of teachers here in the United States, and then "parrot it on" to the next generation of students. There is no real challenge or query as to whether the teaching is really applicable to Indonesia, or what it really means in terms of the problems as they see them. Now these teachers will very often be dealing with the real world and out working on real problems in their moonlighting jobs. But somehow or other, as far as I've been able to tell, there isn't the incentive to try to come back and reevaluate what they themselves are teaching or come up with new approaches, new syllabi, let alone new theories of scientific information.

Now, the corollary of this on the teachers' side as on the students' side, is that I was generally fairly disappointed in the quality of the students that I taught in Indonesia. I recognize the possibilities of very strong cultural biases here, so again I don't want to make too much of it, and I feel rather uncomfortable making such a statement. Yet I didn't find too many who worked very hard, who seemed to have any particular ideas of their own, who read a great deal, who could write a decent theme or research report or anything else. By and large, they were quite passive and what learning they got was mostly in the classroom itself, stemming from the reliance on a verbal tradition of teaching rather than a writing tradition. The libraries are not very good in the first place (if you have 6 thousand books and 15 hundred titles in a faculty of economics or agricultural faculty library you're doing pretty well), once away from one or two of the central universities, but even there the libraries are not well utilized and there isn't much pressure on the students to use them. I often found the libraries would open at eight o'clock in the morning and shut down at two in the afternoon. After two you couldn't use the books because they were locked up. Library policy is focused on keeping book losses low by restricting their use within a building or reading room. The result is that few library resources get into circulation for the benefit of the student.

There's a very real interest on the part of students in the social and political problems of the day. They've been beaten down pretty much in the last

few years so there's a feeling of pessimism around a number of the university campuses that I'm familiar with, but at least the intellectual ferment is there. I think the desire to learn is there, but somehow or other we've got to have a bridge between the need to know, the need to come up with new solutions for and new ideas about the country and about development, and what they put out in the university system. The university system tends to be sterile, and aside from getting the kind of degree that you need to get a good government job, I think the students are quite aware of this and take advantage of it. Now, it's easy to make these kinds of criticisms, and I would feel more guilty than I do about making them in this particular seminar, if I hadn't been saying exactly these same things to Indonesian audiences for a number of years. The audiences, at least the people I was talking to, were very sympathetic and trying very hard to do something about it.

Now for a couple of the problems and a few of the weaknesses I think are very understandable and easy to explain. And I do think we ought to make a sort of a mental effort to understand why the situation is as it is, really why it is, not just superficially, before we can perhaps hope to do something about it. I think that the authoritarianism and the absenteeism are due to the economic situation, the fact that there are just so few professors around they can afford to be the way they are. Professors get a good bit of prestige, with a number of demands being made upon them for help. There isn't any particular need to accept competition or give more prestige and encouragement to the younger people. This is breaking down and gradually changing. In another generation I think there'll be rapid revolution and change as you increase the number of young graduates.

When I first went to Indonesia in 1970, I asked myself how you really judge whether major resources should be put into agricultural economics as opposed to something else. So I just went around talking to a lot of people trying to figure out what a country like Indonesia needs in the way of agricultural economists. Well, I heard that in India they had something like 2,700 Ph.D.s in the social sciences, not just agricultural sciences. Indonesia is a country only one-third the size of India of course, but at the time I was making these preliminary inquiries there were only 6 Ph.D. agricultural economists in the entire country. That's now up to around 9 or 10 at the present time, including a couple of fairly good Indonesian-trained Ph.D.s. But I just finally threw up my hands and concluded

that whatever the proper number should be, it was so far away from 7 or 8 that I could salve my own conscience by trying to get more resources into the social sciences.

In terms of the intellectual apathy, I guess it's partly the same causative mechanism at work. I know a couple of professors who are first rate academics. There is no question in my mind that if they wanted to try they could take a hard look at what they had been taught in the United States and ask how it really applies to the situation in Indonesia, and come up with a completely different course than what they are currently teaching. What they are teaching is really the same thing they learned when they were here in the United States. They don't make any particular excuses about it since they think it's a good way to start out, learning the doctrine from the West and getting the intellectual rigor that this implies. And besides they're too busy to really do anything else anyhow. I think this is in some ways a legitimate excuse, but it's also a commentary on the situation.

In general, there are too few trained people, but perhaps more seriously I think the role of teaching science in the developing situation in Indonesia particularly is still very unclear. There is this feeling that we need more natural scientists and social scientists to go along with development. Certainly you reach a point where the returns to these scientists, in terms of their own income and prestige goes up, so there are incentives to train more people. But I'm not aware of any very good statement or clear sort of picture of what it is exactly that we are expecting from this group of trained people. It's easier to talk about the natural scientists, so I'm talking mostly about the social scientists. One of the surprising things in Indonesia, for example, is that in spite of the fact that for a number of years the country has been run by technocrats (at least as far as much of the economic decision-making is concerned) and in spite of the fact that a great deal of prestige has gone to the economists in the country, it still is not a very highly sought-after career, as indicated by new entrants to the university. The prestige of agricultural economics is much lower than pharmacy, engineering, atomic physics, medicine and law. The fields of applied social science are certainly even further down. Now this is partly because the social scientist has not yet made a very convincing case for what he has to offer to the country. Even within the physical sciences you can invest a lot of resources in technology, in adaptation, and in research, but finding ways to get the farmers to actually adopt these

technologies and finding ways to get the government bureaucracy really organized to assist the farmers are the real problems. These problems appear to be the stumbling blocks.

Within the social sciences themselves, I think there may be two other problems that we can identify. One of them is closely associated with the topic Dr. Liddle was talking about this morning and that is, what kind of a model is it we're trying to follow? Is it a western model or is it some sort of an administered model? Now I didn't make quite as many distinctions as you did - I look at the western model as one in which we are trying to help the farmer become a change-oriented, rational problem solver, able to interpret signals received from the economic world about him, and employing new inputs to increase productivity and to accumulate capital. I think this is the way all of us in this room probably think of as the ideal way in which farmers should be oriented. They should be decision makers; they should be able to change; they should be able to seize upon new ideas and take advantage of whatever situations come along.

In contrast, there is the government directed and sponsored model. It would probably be unfair to call this the Eastern tradition, but just for the sake of dichotomy let's consider it so. In this model it's much more a question of helping the government determine what agricultural inputs, such as food, labor, savings, are necessary to support rural development plans; helping the government to formulate the optimum strategy to insure that farmers play their assigned role. You sort of figure out what the objectives should be and you figure out ways of getting the farmers to do the kinds of things that you want them to do. Emphasis is on obedience, or perhaps alertness to government oriented signals on conformity, on sharing as opposed to more individualism, or on a more atavistic approach to life, on cooperation and being responsible to one's neighbors and to society. These I think are the values that are probably important for either one of the mobilization processes that you have over here.

I suspect that there is a problem within the Indonesian intellectual community as to which one of these models they are following. Certainly I think the U.S. training has tended to inculcate the western model and a certain amount of the new activity that has taken place in some of the agricultural universities embodies aspects of this model, particularly at the Institut Pertanian Bogor. Well, the solutions to some of this are fairly obvious, but some of the points where I would

put particular emphasis are in finding some ways of emphasizing quality within the educational system. In spite of the fact that quantity is so low, I think I would worry more about the quality of the students who are coming into the educational system and the quality of the education they are getting within the system. I think the Indonesians and well-meaning westerners need to know a lot more about rural structure and behavior, because there's just a great paucity of solid information about what is going on in rural areas, about what makes people tick and behave the way they do. In addition to getting a lot more facts and figures, we probably have to find quite new theoretical constructs on which to hang this information. There's a need for some deductive reasoning which will give validity in making predictions from known information and actions. I just don't think that we have had this body of theory, I just don't believe that we in the west have been able to make much of a contribution here, although interestingly enough, many of the real contributions that have been made have come from western scholars rather than from Indonesian scholars themselves. But ultimately this has got to be an Indonesian effort.

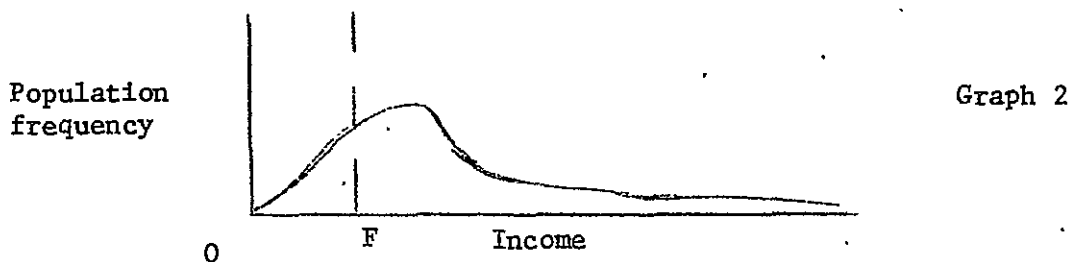
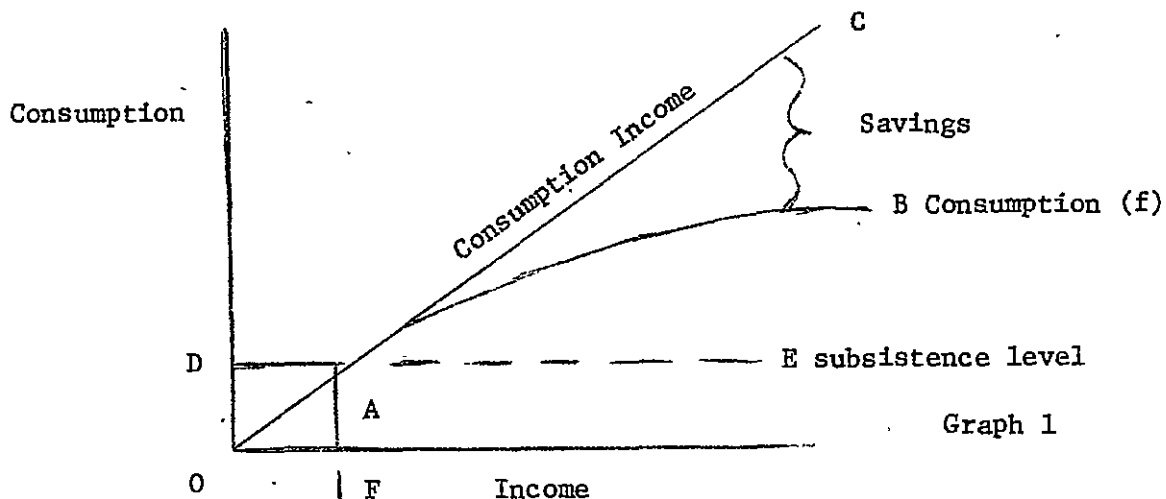
In conclusion I must say that the Indonesian agricultural universities and faculties have been quite good for the students and teachers; the universities have provided a mechanism of upward mobility, a route to fairly good paying jobs and security for both of these groups. They've been good for the government machinery because the bureaucracy is able to function in spite of its many problems far more efficiently because of the investment that has gone into education. However, these agricultural faculties have probably contributed precious little so far directly to the rural development of the country. And I don't think that they will contribute much until there's more of a consensus or widespread agreement on what the goals of rural development really are, and the priority among them. It is not enough to pay lip service to progress in agriculture, and then do your darndest to maintain the same old practices and traditions in an economic system which squeezes as much out of the rural areas as possible so as to encourage and help the development of the other parts of the country. If you really want rural development then you're going to have to give it high priority and a quite different ordering of all kinds of activities in the future.

AN AGRICULTURAL ECONOMIST LOOKS AT THE PROBLEMS
ASSOCIATED WITH SMALL FARM PRODUCTION IN INDONESIA

John T. Scott, Jr.
University of Illinois

Many of the problems of Indonesian small farms are the same as the problems of small farms everywhere. The one major over-riding problem of all small farms is a resource base which is too small. By too small, I mean that the resources are insufficient to consistently produce an operating surplus, so there is something left over after the living expenses of the family have been paid as well as the operating expenses of the farm.

Let us look briefly at this graph of consumption related to income, commonly called the consumption function.



In graph 1, if consumption was exactly equal to income for all levels of income, then consumption would follow the 45° angle line OC. However, there is some level of consumption below which a person cannot go unless he dies. This is commonly called the subsistence level and is shown in this graph as line DE.

This means that those persons whose incomes are below F or from 0 to F must get some of their consumption from the incomes of others. The amount they have to get from other sources is ODA.

Those whose incomes are greater than F usually save part of their income, so the actual consumption function probably follows DAB. Also, as income increases, the proportion of income saved usually increases; or after we reach a subsistence level, consumption usually does not rise as fast as income. Income and consumption cross at point A, income level F .

I don't know what the income distribution is in Indonesia, but if I were guessing from having been there and observed the situation, I would hypothesize that it looks something like the distribution function shown in the second graph with the bulk of the population bunched around the subsistence level and a few people with higher incomes. We would say that income is drastically skewed to the right.

How do people in Indonesia subsist whose incomes are below the subsistence level? There are four major ways and in order by importance they are, relatives, friends, begging and stealing. A fifth way that I am not sure how to order is government relief. As in most countries, government relief takes many forms. Since the army is much larger than required for national defense, many in the army are really on government relief. There are more government functionaries at all levels than needed and many of these persons are essentially on government relief. There is a ceiling on the price of rice and whenever the true market price is above the ceiling price, whoever buys rice receives some government relief, so the rich and poor alike who consume rice get some government relief. For farmers, whenever a subsistence farmer gets a government loan through one of the agricultural programs and then fails to pay it back, this is government relief. Whenever farmers buy fertilizer below the market price through the government, this is a form of relief. So relief takes many forms, but there is very little outright relief. A person must qualify in some way.

Consequently, having a small resource base to start with, the small farmer has no operating surplus to use for expansion and no collateral to borrow money to expand his resource base. If his farm is so small that he is just at the subsistence level in the average year, then he is in a precarious position because in a poor year he has to borrow on what collateral he has, and in a year he has

above subsistence level returns, these returns are used to pay back what he has borrowed plus the interest. Even if he would come out even on the average, the interest when he has to borrow pulls him behind. It is very difficult to persuade this farmer to use some of the new technologies, such as a new rice variety, for at least two reasons: (1) the new technologies require substantially more capital for cash inputs, and in his position he does not want to be any further into debt, and (2) there is always some risk in changing techniques. He knows what the methods and varieties which he has been using will do for him and he does not know the new ones or how to apply them. Failure at the subsistence level means death; whereas, if you or I lose some money in the stock market or the commodity market all it probably means is that it hurts our ego and maybe our next new car will have to be a "Chevrolet rather than a Buick!"

If the price of grain rises relative to other things, as has recently occurred in world markets, we might assume this would make the subsistence farmer better off. If he did have some small surplus to sell to buy other necessities, then he might be somewhat better off. If he eats all the grain he produces, in order to subsist, a higher price for grain is not going to make him better off.

For those farmers whose resources are not enough to produce a subsistence level, several things can happen and usually do: (1) they lose most of the resources they have because they borrow to consume, (2) they become part-time farmers on their own land and work at other occupations or for others at different times of the year, such as peddlars in the marketing system, farm labor for larger farmers, or they migrate in the off farm seasons to urban areas where they may get part time work, and (3) they rent land from larger landowners. The size of a subsistence farm varies greatly depending on basic productivity, irrigation, and type of farm. It would vary probably from about 1/2 hectare in the irrigated wet rice areas to several hectares on the unproductive uplands and where Swidden type agriculture is practiced.

What are some of the other problems in Indonesia which aggravate the general problem of lack of resources for small farmers? These can be generally thrown into two classes: Internal production problems and externalities. However, the intersection of these two sets is not a null set. That is, externalities affect internal production problems.

From an internal standpoint, how efficient are small Indonesian farms? Efficient relative to what? each other, larger farms, or similar farms elsewhere in the world? I really have no basis to talk very much about the efficiency of small Indonesian farms, but from casual observation (no data) sort of a windshield appraisal, I believe they are rather efficient. I cannot imagine how they could produce more than they are unless they get higher yields; and with respect to cultural practices, there is very little difference in the techniques used by small farms and large farms. If anything, the large farms may be slightly less intensive and produce less per hectare than the small farms, although all of these things are very difficult to measure. At least the data collected by the agro-economic survey project in Indonesia support these general contentions. I will spend the rest of my time talking about externalities, because these are more readily observable and verifiable.

(1) The first externality affecting farmers as well as consumers concerns the price of rice and its fluctuations. The market price pattern on the farm for rice from harvest to harvest shows a much greater variation in price than the market price to the consumer. Also there is a substantial difference between the farmer price of rice and the consumer price of rice in Djakarta. The farmer price during harvest is often only half as much as is paid by consumers between harvest periods. This means the marketing system often absorbs as much of the value of the product as the farmer receives. This is an extremely large marketing cost considering there is very little processing done by the market after it leaves the farmer's hands. There are several reasons for this large marketing cost. First, many of the smaller farmers must sell all their grain at harvest to pay off debts. They sell at low harvest time prices and often have to buy back from the market at a higher price for their own consumption, thus going further behind financially. The money lender and the rice merchant thus stand in a monopsony position to make substantially more profit than they could otherwise. In fact, this system aggravates the swing in prices. Surveys indicate that there is a large movement of rice during harvest into the hands of storage holders and merchants in the metropolitan cities and then there is actually a movement back out to the villages at high prices before the next harvest.

The government has a rice price support policy as well as price ceiling policy. However, the rice support price is paid to rice millers or merchants and not to

farmers. Changing this policy to buy rice directly from farmers at the support price could substantially increase the returns to small farmers and improve their capability to improve yields with cash inputs such as fertilizer and insecticides. Also construction of some regional storage facilities by the government in the larger villages, perhaps the district headquarters village, would reduce the cost of rice transport and storage increasing the average farmer price and reducing the average consumer price.

(2) The second externality concerns economics in marketing. There are few scale economies possible for small farmers in Indonesia either in production or in marketing. Small farmers have to pay the highest prices for inputs and get the lowest prices for products sold partly because of the small quantities that are handled by and for small farmers. When a farmer sells only a small bag or maybe a few quintals of rice at a time, it can hardly be moved with a 1,000 bushel truck like U.S. corn farmers move grain directly from their own storage to terminal elevators. I am certainly in no position to say that the small quantity marketing system that exists in Indonesia is not efficient. I suspect that the physical movement of goods is probably fairly efficient for the small lots moved.

(3) A third externality involves government rice improvement programs. The government has tried several rice production improvement programs. There was Inmas, then Bimas, then Improved Bimas. These government programs are good in their overall conception, but have fallen far short in their application. One shortfall is the risk taken by small farmers in a new technique; another shortfall is that all parts of the package must be carried out regardless of the situation on an individual farm, whereas all farmers know just as the Indonesian Pertani knows that the same level of fertilizer and the same way of doing things is not profitable for all alike. Also many government loans to farmers are taken as subsistence payments rather than production loans. Many such loans are not paid back.

In application of the Bimas program, the individual farmer should be allowed to decide how much of the technology to use in his own case rather than be forced to use a package deal. Also there should be a distinction made between subsistence loans and production loans rather than the government expecting that loans which clearly go for subsistence be paid back as production loans.

Another mistake in application was made recently when a share of the crop was taken from the Bimas farmers by the government at a price below the market

price. This amounted to a rice tax and some village chiefs and other government officials literally lost their heads by farmers disgruntled by the program.

Whether government rice improvement programs can survive these kinds of actions in their application is highly questionable.

(4) A viable credit program is needed which separates subsistence loans from production loans and makes credit available at reasonable interest. If it could be arranged so there might be some joint responsibility of the village to pay back production type credit rather than individual responsibility to the credit agency, so that the social weight of the village could be brought to bear on laggard individuals, production credit might prove much more useful to small farmers as well as to society as a whole.

(5) When subsistence farmers fall behind financially, their land often passes to larger farmers or larger landholders. Also as food becomes more dear, the price of productive land rises mitigating toward a land holding class and a larger landless class. What more did land contribute this year to production than it did last year or five or ten years ago? Why then should the landholder reap the windfall gain in land prices which occurred because of externalities in the society as a whole? As time progresses, I see the potential development of a serious problem involving who controls the right to produce in agriculture through land ownership and the consequent distribution of wealth and income.

(6) A massive effort must be made to provide alternative employment opportunities off the farm. Throughout history the main salvation for people on small and below subsistence level farms in the industrialized countries has been the opportunity to get good jobs in the non-farm economy. Their land resources were then absorbed by other adjoining farms making everyone better off. Those who left the farm were better off with better jobs in town and those who remained in agriculture were better off because they had larger farms and more resources with which to work. Some additional off-farm work is now being provided by the rapidly developing lumber industry. Many of these jobs are in Kalimantan, but also many are in Java in the sawmills, plywood industry and other lumber processing industries.

(7) Additional investment must be made to provide literally millions of jobs. Indonesia has the opportunity to meet this challenge more than any other of the present highly populated Asian countries, because they have been uniquely blessed with oil, lumber and other natural resources if only the income from these resources

can be used in the right way. Indonesia is currently importing many light consumer goods from Japan and Taiwan. These goods could be made in Indonesia with Indonesian labor just as well by judicious development of light industry. This light industry could be geographically distributed to bring jobs to the people, reducing the problems caused by mass migration of people to Djakarta and a few other metropolitan areas.

(8) Another point is one that is obvious and everyone is making these days and that is population control. If another generation passes without providing off-farm job opportunities or a better program to apply known and developing farm technology, then every farm in Indonesia will be below the subsistence level. That is as clear as the writing on the wall.

I want to tell you an incident that happened while I was in Indonesia. An Indonesian who I believe to be one of the best scientists in Indonesia, a man with wide general knowledge, great perception and research enthusiasm, made a remark to me which I thought uncharacteristic of a researcher who surely must believe in the fruits of science. We were on a field trip visiting one of the plantations in the unirrigated hills east of Bogor. Four or five young children belonging to the plantation manager were playing in the dirt yard around the house. We were sitting on the porch after lunch contemplating the world around us and this generally optimistic research scientist said to me, "You know, I can't help but believe that those children are going to have a much harder life than we have had."

Finally, I want to say that I don't believe it has to be this way! (1) Many countries have shown that population control is possible, (2) Indonesia has the resources to obtain capital to develop off-farm employment, (3) Indonesia has the resources (the oil and gas) to produce large amounts of nitrogen fertilizer and other chemical inputs to increase yields rapidly, and (4) it is possible through education and planning to provide credit, new varieties, new technology, irrigation and the economic and marketing incentives to increase food production in Indonesia by making the small farmer better off, both for those who leave the farm and for those who remain.

SOIL RESOURCES OF INDONESIA

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I think many people would agree that if a nation has a diversity and abundance of productive soils and a mild, favorable climate, it has the natural conditions for providing the basic needs for its people. Indonesia is fortunate to have them. I think you might also agree that a discussion of the soil resources of Indonesia is a logical point for initial discussions on agricultural development.

To many persons a discussion of tropical soils conjures up a visualization of a reddish colored, deeply weathered soil, acid and low in nutrients, high in iron and aluminum hydrated oxides, with a limited profile development. For the upland soils of the humid tropics, this image will serve quite well. However, there is probably greater variability in kinds of soils in the tropic zone than there is in the temperate regions of the world. And Indonesia is no exception. Five major factors are responsible for variations in soil formation; they are climate, parent material, vegetation, topography, and time.

In Indonesia, sitting astride the equator and scattered over 3,000 miles from east to west, a great variety of soils can be found on the many islands. Part of this is due to the wide differences in annual rainfall. For instance in Sumatra and West Java, it is not uncommon to find over 200 inches of precipitation each year, whereas in the Eastern island area such as Timor, annual rainfall may be as little as 30 inches in as short a time as 3 to 4 months. To confound this picture, the mountains - even single volcanic peaks, act as collectors and storage reservoirs of moisture to support surface flow of rivers during much or all of the year. Stream flow varies greatly with the season. During the rainy months, rivers are heavy with silt and clay attesting to accelerated erosion in the watersheds, whereas in the dry season, stream flow is markedly reduced.

Another reason for the variability in soil types is the difference in parent material from which Indonesian soils have been formed. In Java, Bali, and parts of Sumatra volcanic dust and debris makes up the base for soil development; in other cases it is residual igneous material or sedimentary rocks such as limestone. Southeast of Yogyakarta close to the southern coast there exists an interesting

area of black soils developed on the surface of a limestone plateau. These soils are very sticky when wet and crack badly during extended dry periods. Topographically the area exhibits good examples of Karst features found in other regions of the world developed from surface limestone deposits. Along the northern coastal areas of Java many of the soils are developed from fine alluvial material washed out and down from the mountains or hills. The southern coast of Kalimantan is so low-lying it has extensive tidal deposits and surface accumulations of organic matter.

Vegetation, which has a distinct effect on the kind of soil formed in the tropics, varies mainly as a function of precipitation and to some extent on mountain slopes by temperature (altitude). With the exception of some sections of the eastern islands, Indonesia's natural vegetative cover was forest. In Java only the most inaccessible areas have a primary forest cover. Some upland areas, cleared but not continuously cultivated, have reverted to coarse, useless grasses characterized by "alang-alang" (*Imperata cylindrica*). Undisturbed forest areas as found in the remote regions of Sumatra, Kalimantan, and West Irian are made up of a great variety of tree and shrub species. Such jungle areas appear lush and one might assume the soils that support them are very fertile, but generally this is not the case. Plant nutrients in this ecological cycle are in a delicate balance. Stripping away the forest followed by cultivation of annual crops results in shifting cultivation practices, particularly in the hilly regions.

Because much of Indonesia can be classed as either lowland or mountainous highlands, topography has also had a significant effect on the kind of soils one finds in Indonesia. Soils on the upper slopes of mountain areas tend to be coarse and excessively drained, whereas the intermediate and lower slopes have fine enough soil material usually to permit puddling for the production of paddy rice. Probably the most productive soils of Indonesia can be found in Central Java lying at the base of recently active volcanic mountains. These young soils are usually deep, high in silt and clay, contain a moderate amount of organic matter, and possess a rich supply of primary minerals containing nutrients needed for intensive crop production. Coastal lowlands in Java and S. Kalimantan adjacent to the Java Sea and along the east coast of Sumatra are either swampy or poorly drained. They flood extensively during the rainy season and generally, when cleared, can be utilized as wet rice lands. If these areas are only a few feet above sea level,

they will be subject to tidal overflow. Reclamation of these tidal zones often presents special problems since once cleared of swamp vegetation and partially drained, the soil may become extremely acid as a result of the oxidation of sulfide minerals to sulfuric acid.

Let's talk about crop production on two major land areas in Java: (1) the mountain highlands and well drained upland soils, and (2) the lowlands, inter-mountain valleys, and lower mountain slopes. This is, of course, too simplistic a separation, but it will help to illustrate some points.

Population pressure has forced many people to move from the lowlands into the hilly/mountain areas to find available land to crop. As a result of natural erosion, chemical weathering over centuries, and man's recent activities, these soils are of relatively low fertility. This means that shifting cultivation is commonly practiced. In this situation the forest or bush is cut, allowed to dry out, and then burned. The soil may be tilled, but often there is a minimum of cultivation and weed control during the first season of cropping. Ash from burning provides a fair supply of mineral nutrients for the first crop, which usually results in a reasonable yield of maize, upland rice, cassava, sweet potatoes, or vegetables. However, the second year's cropping on the same area invariably leads to lower crop yields, and successively lower levels for the third season. The problem is that available nutrients are not released rapidly enough to sustain and permit good stands of annual crops. Few nutrients are returned to the soil as crop residues or animal manures. Much of the organic matter in the surface layer is oxidized as a result of stirring the soil and exposing the surface to the direct sunlight, promoting microbial decomposition. On sloping lands an unprotected soil surface is also exposed to the beating and washing effects of heavy rains. Finally after 3 or 4 years of cropping, the plot is abandoned to fallow to grow back to bush, weeds, trees, or grass. These plants provide a vegetative cover and some species are deep-rooted, thereby drawing nutrients from the subsoil with a subsequent slow accumulation in the surface. After 10 to 15 years the soil regains its natural fertility. Sometimes this practice is called field rotation and a family may have 3 or 4 small plots in different stages of bush fallow. When population pressure reduces the time of the fallow period, the farmer may resort to adding what sources of organic matter he can find - compound sweepings, decayed leaves, young shoots of trees, animal

residues, etc. Incidentally, garden areas in or close to villages often can be cropped every year as a result of receiving organic residues and debris from the village.

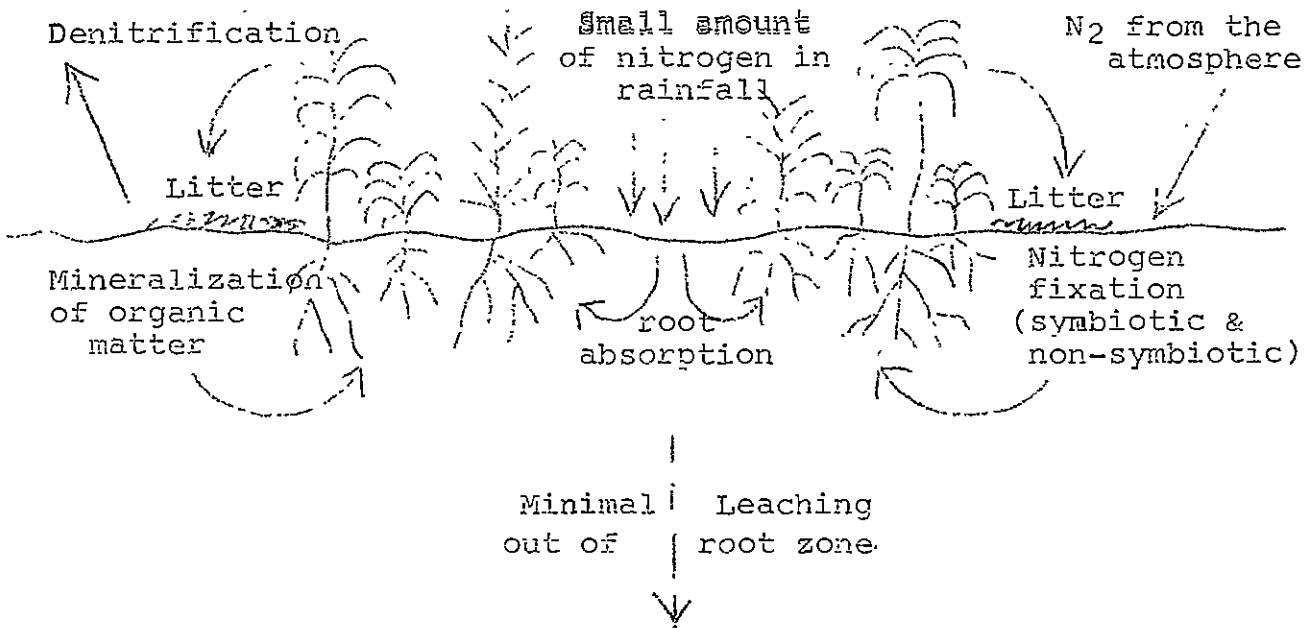
The soils of the lowlands are generally more fertile, containing a higher content of silt and clay. They are likely to be of more recent origin as a result of accumulated sediments. They are likely to be less intensively weathering since they are younger and less permeable to percolating rainfall. Because they are less well drained, these soils often have a higher organic matter content. This situation permits continued cropping since the available nutrient supply is maintained at a distinctly higher level. Paddy culture of rice is a natural on these soils and continued cultivation of sawah has been practiced for centuries in some areas.

There are some interesting aspects of paddy culture that we don't know a lot about. Fixation of nitrogen by blue-green algae is one; it certainly takes place, but the total amount of N added is questionable. Some denitrification likely takes place as well under anaerobic conditions, but here again we are not sure how much. In many areas irrigation water flows from terrace to terrace in response to gravity and carries with it soluble nutrients and sediments. Irrigating from streams and ponds in areas of high population density definitely adds nitrogen to paddy areas.

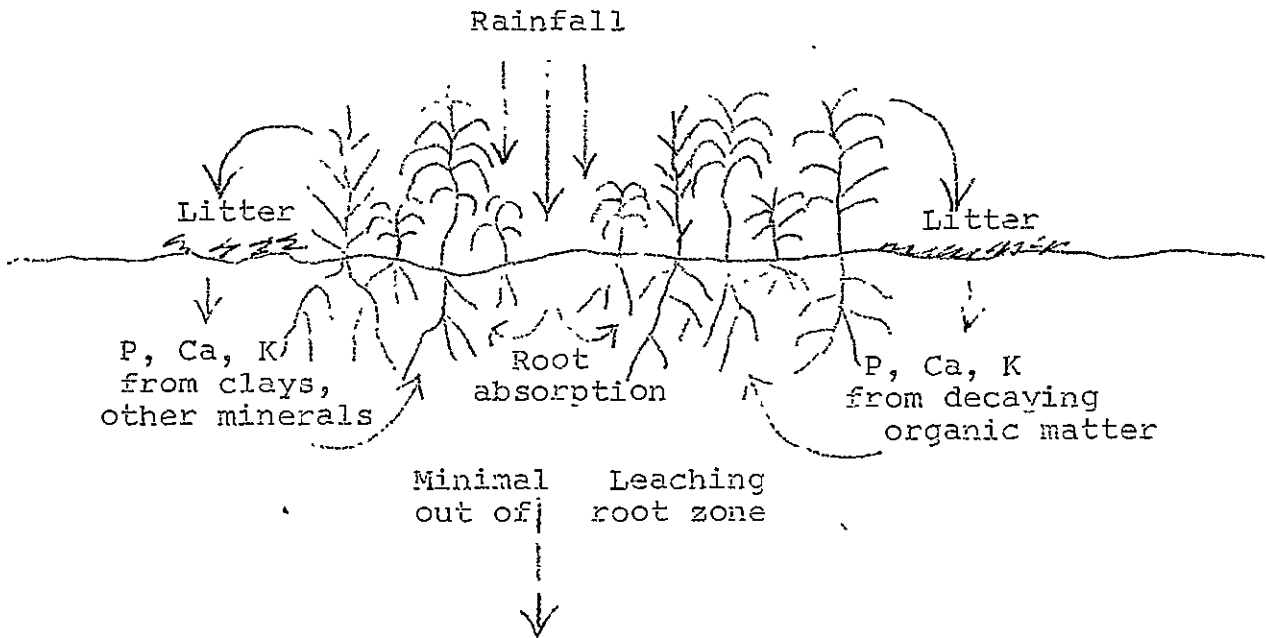
The general nitrogen status of soil with a vegetative cover is schematically presented in Figure 1. A small amount of the element, perhaps 5 to 10 kg. per hectare in the form of nitrates or ammonia is deposited over the land annually during rainstorms. A much larger amount of nitrogen is fixed from the air by symbiotic bacteria in association with legume shrubs and trees, with leguminous crops, or by the action of the non-symbiotic N-fixing bacteria in the soil. Decomposition of the residue of surface litter, decaying roots, and soil organic matter provides a fairly constant source of soluble nitrogen for plants of all kinds in an ecologically balanced forest situation. Upsetting this balance by cutting, burning, collecting litter, or by seasonal food cropping leads to a lower supply of available nitrogen. Fixation of nitrogen from the air is usually balanced by small leaching losses and some denitrification back to the atmosphere.

The gross status relative to mineral nutrients such as calcium, magnesium, phosphorus, sulfur, and various micronutrients is even simpler to understand than that of nitrogen. With the exception of sulfur, the entire supply (in the absence

NITROGEN CYCLE



MINERAL CYCLE



of dust) of these nutrients comes from the weathering of soil minerals and organic matter. In Figure 2, a diagrammatic picture of the cycling of such nutrients is presented. Root absorption of mineral nutrients and their utilization is followed by accumulation in surface litter and decaying roots. Microbial decomposition of these residues releases some of the nutrients from complex organic compounds. This supply plus that from the weathering of soil particles and soil organic matter provides soluble forms for uptake by plant roots. Leaching losses under stable forest conditions are minimal, but shifting cultivation on upland soils depletes this supply through crop removal, surface erosion, accelerated organic matter decomposition, and leaching.

There is a lot of evidence that application of fertilizers to soils in Indonesia will result in improved yields of annual crops, especially where higher yielding varieties are used and where stands of crops are of normal to high density. The Freedom from Hunger Campaign (FFHC) under FAO leadership has been active in establishing crop trials with fertilizers in Java. In some cases these increases provide a good economic return to the farmer; in some cases not. The amount of field trial data is limited and there hasn't been a lot of research on correlation between field response of crops to fertilizer and useful chemical soil tests. Detailed soil surveys are also few in number, usually restricted to special development programs which require a knowledge of soils before injection of substantial amounts of capital and effort. Prior to 1940, Dutch soil scientists carried out some very good surveys and classification studies and gained an excellent knowledge of tropical soils. However, they concentrated their work in areas most suited to plantation crops such as rubber, tea, coffee, sugar cane, and tobacco.

Currently the Ministry of Agriculture is expanding its capacity to evaluate the soil resources of the country. Some assistance to the Soils Research Institute is being provided by specialists from Japan, the Netherlands, and the United States. At the Bogor Agricultural University and the University of Gadjah Mada, staff are gaining experience in using soil tests as a measure of the fertilizer needs of soils. The MUCIA project has provided short term consultants in the area of soil fertility/chemistry to these two institutions. Both of these institutions are working under government sponsorship demonstrating that reclamation of tidal areas can be successfully carried out in southern Sumatra and southern Kalimantan. The problem is that there are limited numbers of trained soil scientists and the

accumulated knowledge base is small.

Up to 1968, Indonesia imported virtually all of the commercial fertilizer it used. Nitrogen fertilizer in the form of urea is now being manufactured at Palembang in South Sumatra. Production was about 250,000 tons as of 1972, and plant capacity will be doubled by 1976. However, even this expansion cannot likely take care of farmer demand and specific government programs pushing food production during 1975-80. Thus Indonesia will be purchasing some nitrogen fertilizer as well as most of its phosphates on the world market. Fortunately, it will have the foreign exchange to do so. The Ministry of Agriculture in cooperation with USAID and TVA has been testing the effectiveness of sulfur-coated urea. This new fertilizer material tends to release its nitrogen more slowly than ordinary urea under paddy conditions thereby increasing its efficiency for rice crops. Test results in Indonesia and other S.E. Asian countries are being evaluated. Some selected grades of rock phosphate have shown in field tests to be almost as effective in supplying fertilizer phosphorus to crops as superphosphate. Use of finely ground rock might be a way for Indonesian farmers on some soils to get cheaper fertilizer.

There is clear evidence that Indonesian farmers will use increasing amounts of commercial fertilizer if it is available and if it provides them with good economic returns. As soil and crop management practices become more involved, the cultivator will require more technical information on how best to utilize fertilizer along with other agricultural inputs.

CROP PRODUCTION IN INDONESIA - CAN INDONESIA FEED HER PEOPLE?

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The answer to the question posed in the title must be YES. Any other answer is unacceptable in terms of human suffering and the future of Indonesia as a nation. This writer is optimistic that in spite of the rapidly expanding population, Indonesia can and will become self-sufficient and can even improve the quality of the diet of her people. The following two sections will provide the basis for the optimism and offer suggestions for future needs or opportunities.

1. Optimism

Indonesia is adopting agricultural technology at an increasing rate. When such technology is used, Indonesia's rice yields have been comparable to those reported anywhere. At present Indonesia seems to be politically stable and is not only studying rural social and educational problems, but attacking them on many fronts. The government has given agriculture high priority and has much more of the wherewithal for agricultural development than many tropical or developing countries. Development plans have included agricultural package plans based upon latest technology, and education has been emphasized. Agricultural leaders have been selected on the basis of training and merit and there is a feeling of optimism and inherent enthusiasm among them. Indonesian farmers are industrious and do not seemingly have the built-in conservatism toward new ideas or the religious taboos present in some tropical areas.

The establishment of two primary agricultural colleges (Bogor and Gadjah Mada) with graduate programs and approximately 20 regional agricultural colleges, and the government's increasing financial support for programs and staff bodes well for the future. These colleges have made far more progress since their beginning than U.S. land-grant colleges did during their first 25 years.

Agriculture in the industrialized temperate zones cannot capitalize on year-round cropping. While double cropping is an increasing practice in the U.S. and certain other temperate areas, the growing of three crops is impossible and labor is not available. Indonesia is fortunate and must look to relay or continuous cropping as a means of producing more food annually from a given area of land.

Intercropping or the planting of the next crop before the present one matures has great potential and is being researched.

Fortunately the foreboding weather predictions by meteorologists for some areas of the world have not generally extended to latitudes as low as Indonesia. If some of these forecasts hold true, there will be even more pressure and opportunity for tropical areas to become agricultural exporters. There are undeveloped, unpopulated areas on some of the outer Indonesian islands that offer long-range potential for the growing of food or estate crops.

Progress is being made toward one language (Bahasa Indonesian) to replace the many dialects, and this will ultimately facilitate communication and the adoption of new technology. Transportation improvements are being made, and this has long-range positive agricultural development benefits. Some programs are already initiated which extend credit to farmers for improved seed, fertilizer and chemicals.

2. Suggestions for the future

The primary means of meeting Indonesia's increasing food needs is by the continued rapid adoption and development of agricultural technology. Concurrently, related transportation, distribution, marketing, and credit must receive attention. Germ plasma banks must be established for the primary crops and special attention given to screening for resistance to the myriad of indigenous insect and disease pests. The most economical and safest way for the farmer to control such pests is by the use of resistant varieties. More basic research is needed on the primary plant disease and insect pests: life cycles, alternate hosts, as well as biological and chemical control methods. Plant breeding programs must be designed for high yield in various climatic and soil regions of the country, and thus widespread advanced testing of genetic material will be necessary before release.

On the island of Java the primary challenge is to produce more per acre per year. The temperature permits year around cropping and in many areas with available water, crops could be grown continuously. Growing time cannot be wasted between harvest of a previous crop and planting of the next one. Intercropping or relay cropping where the next crop is planted before the present one matures has great possibilities for increasing crop yields in Indonesia, and labor to accomplish this is present. Theoretically, having a crop specie in its grand period of

growth or dry matter accumulation continuously should be the objective of much new and innovative research. Early maturing varieties or crop species should be included or developed for such intensive cropping systems.

Such labor intensive cropping systems as described above require constant water availability which is not present in many areas. Thus even more attention could be given by the government of Indonesia to water storage sites (dams), irrigation systems, and a national survey of underground water supplies and the possible existence of aquifers. There appeared to be many excellent sites in certain areas of Indonesia for dams and aquifers do exist in certain volcanic islands (Hawaii, for example).

More research and educational programs should be devoted to increasing yield of corn. Many upland soil areas and even sawah rice growing areas could grow this grain crop during the dry season. The present crop is uniformly nitrogen-deficient and extremely low yielding. The belief that corn does not respond to nitrogen as does rice is partly due to generations of selection at low fertility levels and the evolution of a plant and ear type which truly lacks the ability to do so. Quick attention must also be given to development of types resistant to downy mildew, a terribly destructive disease.

At an ASEAN soybean conference held in Bogor in 1974 a nutritionist reported that the Indonesian protein intake is 35 grams per day vs. FAO recommendations of 55 grams per capita per day. Therefore, much research attention needs to be given to legume seed crops and particularly soybeans because of the contribution they could make to protein diet needs. Excellent soybean growth and yields have been obtained in experimental plots, and educational or BIMAS package programs should be initiated with this crop specie.

A great deal more research should be devoted to the root food crops. A vigorous selection and breeding program on cassava and sweet potato for higher yields, earlier maturity, disease resistance and perhaps even an increase in protein content seems appropriate.

Improved seed production and processing centers are needed as Indonesian plant breeding programs become more productive. The agriculture of a country is correlated with the quality of the seed used. Once a new variety is distributed, individual farmers must use more care in storing their seed. One possibility might be after drying for the farmer to place planting seed in their plastic Urea

fertilizer bags, add an insecticide, and seal.

Future crop production needs of Indonesia simply cannot be met without increased availability and use of fertilizer. Nitrogen is the primary element needed, and phosphorus is deficient on many soils. Fortunately Indonesia does have petroleum products in excess of needs, and Pertamina should invest such profits in fertilizer plants. Well-fed plants not only produce more but are generally higher in nutritional value.

The present BIMAS programs on certain crops are excellent and should be encouraged. Fertility recommendations therein should be based more on soil types or needs rather than uniform rates or amounts. More fertility trials are needed, and the yield results should be correlated with soil types and chemical soil test values. Test demonstration farms might be used for this purpose. Fertility and other research should be for the future and not have the built-in constraints of "present custom."

New technology should continue to be introduced and developed for the estate crops to provide Indonesia more favorable trade balances. New plantings should be established in areas of topography, climate and soil type not suitable for rice growing and perhaps in areas where population pressure is less.

Grassland and forage research in the drier areas and less populated islands need more attention whereas in Java, ruminant livestock will compete with the food crops. They can be profitable enterprises and supply badly needed protein when grown on larger land holdings on certain of the other islands. Animal rate of gain and health could be improved by research. The clearing of outer islands and transmigration might be more successful if more attention was paid to the soil type and to the persons selected. Generally successful land pioneers on small holdings must be experienced farmers with a strong desire to move and succeed.

More planning should go into the present thriving timber industry on some of the islands. Prevention of long-term erosion and future best land use for such areas needs to be worked out now.

In the primary agricultural areas farmer cooperatives might be encouraged to organize and build storage facilities and market the primary agricultural inputs needed: fertilizer, seed and chemicals. Sprayers or small threshers might be made available to members on a small rental basis.

Because of small land holdings, more cottage type industries are needed. With increasing tourism, too few Indonesian articles other than Batik are for sale. More use of yards for vegetables and fruits for home consumption would seem in order.

And last but not least, there needs to be more teamwork between agricultural scientists of varying disciplines, between extension and research, and between universities, government research organizations, national planning boards and industry.

If Indonesia's present positive planning, recognition of needs of agriculture, and selection of agricultural leadership based on training and merit or performance continues, she can feed her people and assume a much more important place among the nations of the world.

THE ENTOMOLOGICAL SIDE OF PLANT PROTECTION

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INTRODUCTION

From a biological standpoint insects are a very successful class of animals. There are probably 750,000 named species worldwide, which constitutes over three-quarters of the animal kingdom. Yet this is only part of the story. As a group they have two other biological assets - an enormous reproductive capacity and efficient mobility. Unimpeded by natural forces such as parasites, predators, available food supply and climatic limitations they would quickly cover the earth. Among controlling factors, climatic control can be very important and in places like Michigan, severe winters break the continuous buildup of insect populations. In Indonesia the warm weather, characteristic of tropical areas, makes for an ideal insect rearing situation and tends to make control more difficult. Pests introduced accidentally have greater chances of survival, leading to a greater number of crop pests.

In addition to ecological factors favoring insect outbreaks, high density human populations in agricultural areas of Indonesia complicate the environmental problems associated with the use of pesticides. Pesticide residues in food, soil and water and the use of pesticides so as to avoid harming the applicator and the environment need specialized study, education and legislation.

The Plant Protection Service

The Plant Protection Service of the Director General of Agriculture in the Ministry of Agriculture has major responsibility for crop protection programs. Quoting from the 1970 report of this agency, "Plant protection research, extension and training facilities . . . were created to tackle the pest and disease problems. Field protection operations were undertaken by the plant protection section at the national level and through the Extension Service in the provinces." Control consists basically of the distribution and application of insecticides to outbreak areas. Field evaluation of insecticides is conducted by the Plant Protection Service, usually following screening tests at research stations. An attempt is being made to develop a survey system which will identify and report

pest conditions so that control programs may be set up to nip outbreaks in the bud. Farmers are instructed through extension programs.

The Use of Insecticides

The use of insecticides has continually increased in Indonesia since the 1950's. Worldwide proliferation and use of new synthetic pesticides increased enormously following the introduction of DDT during World War II. In spite of worldwide environmental problems, and research into alternative methods, the use of insecticides is still increasing everywhere. From the farmers' standpoint they accomplish the necessary immediate control job and from a total food production standpoint they are doing much to avert worldwide famine. They are also doing much to hold in check malaria and other insect-borne diseases.

Health problems and deaths have resulted from pesticide use in Indonesia. Leaking pesticide containers have contaminated rice in storage and the rice has killed people. Pesticides have been sold in unlabelled containers in markets. Many of the pesticides commonly used, such as Endrin, have very high mammalian toxicity. An adequate Pesticide Law can do much to solve or improve pesticide problems associated with human health, food contamination, fish and wildlife damage and other environmental pollution problems. A law can help ensure the proper use of safer and more effective insecticides. Since my visit to Indonesia in 1971 a Pesticide Law has been instituted.

For a pesticide law to work or evolve to meet the requirements of new knowledge and changing conditions, research often of a detailed and sophisticated nature is needed. For example, our Pesticide Research Center at Michigan State University is one of many agencies very much involved in basic and applied research projects which provide the information on which adequate legislation must hinge. Insect toxicologists, biochemists, physiologists, taxonomists, ecologists, etc., are needed to identify problems and carry out research. Indonesia needs much research along these lines and is working toward these objectives but it takes time to develop the whole infrastructure needed to produce the labs, the equipment and the multi-disciplined personnel needed to do the job in a comprehensive way. Efforts through MUCIA to bring university entomology departments to graduate school status are prerequisite to success in these endeavours and specialized training to develop personnel of these departments as quickly as possible is the prime factor on which eventual success hinges.

Pest Management or Integrated Control

The most significant change in entomology in recent years has been one of philosophical attitude toward pest control. With the introduction of DDT in the early 1940's, there developed an era of unreserved optimism that we could rely on a single method of pest control, that is control of insects by pesticides. Dramatic successes in crop protection and disease control led to the use of enormous quantities of pesticides worldwide. The inadequacy of excessive reliance on pesticides soon began to show up in various ways. House flies soon developed strains resistant to DDT and other examples of resistance followed; secondary pests became primary pests and excessive resurgence of treated pests occurred when their biological control agents were destroyed; various types of environmental pollution developed and persistent chemicals were found distributed widely in the environment. Concern for the sum total of these problems led to taking a more critical look at all aspects of insect control. Students of entomology, ecologists, statisticians felt that with our modern technology, computers and greater knowledge of insect behavior, we could surely find more acceptable ways than a unilateral unending commitment to chemical poisons.

This conviction has led to increased entomological research into all aspects of insect control. Successes with male sterility, biological control and other aspects have been more rapid than was expected a few years ago. Out of these successes has evolved the concept that the way of the future must be one of expanded, broad-based ecological studies of major pests with the objective of "plugging in" all possible methods of control in an integrated fashion. Pesticides will be "plugged in", in such a way and at such a time that they do not destroy biological control agents or cause objectional side effects. Biological control by itself is receiving much more emphasis.

Early in my stay in Indonesia I realized that it would be well to stress with students and staff that it was up to professional entomologists to move into this new era or new concept of pest management. Gadjah Mada entomologists have moved into preliminary studies of rice pests leading to integration of several control methods, and dedication to the concept is evident among Indonesian entomologists.

Plant Quarantine

Indonesia like most other countries tries to prevent the introduction of serious foreign pests in sea freight, air freight, personal luggage or other ways.

Inspectors and support personnel are hired, trained and equipped. Quarantine stations have been developed in many parts of Indonesia and fumigation units are available at major ports of entry. There were 90 quarantine inspectors in 1971. The Khapra beetle, one of the worst pests of stored grain, was intercepted and eradicated in 1970.

Agricultural Air Unit

Two spray planes operated under the Ministry of Agriculture and the Air Force were made available in 1971 for crop spraying, aerial survey and broad-casting seed and fertilizer. From the standpoint of insect control by chemicals, airplanes are efficient but they can also greatly increase the hazards of environmental contamination and efficient destruction of beneficial biological control agencies, with resultant outbreaks of secondary pests.

Agencies and Personnel

Many agencies including Directorates, research institutes, centers and stations and universities have responsibilities associated with insect control. In visiting several of these I was impressed with the communication and cooperation between entomologists at the universities and the Federal agencies. Senior students were given the opportunity to carry out required research projects at appropriate research centers.

Among entomologists the greatest lack is specialized, more sophisticated research training. This is slowly coming about as staff get away for advanced training. For continual production and replacement of scientists it is essential that university staff, particularly at IPB and Gadjah Mada complete their graduate training and assume their role of training graduate students in the appropriate specialties. In order to produce the scientists for research centers or elsewhere the university staff must have research funds, equipment, support personnel, graduate assistantships and time free from other duties. This concept needs much greater acceptance and execution for necessary progress in entomology.

Entomological extension work has focused on control of pests by pesticides and well organized projects have been carried to the farmers. The extension worker will have a more complicated responsibility as expanded research leads to more sophisticated biological and integrated control measures and an increased understanding of environmental protection.

SOME MAJOR PESTS

All agricultural crops everywhere have a host of insect pests and Indonesia is no exception.

Rice Pests

A 1970 report of the Plant Protection Service estimated that annual losses in rice production due to stem borers, gall midges, and leafhoppers was 704,000 tons valued at 10,560,000,000 Rupiah in Java, South Sulawesi and South Sumatra. This works out to 13% of the total production of rice of these areas.

The stem borers which are larvae of moths and the gall midges are widespread, persistent pests. The leafhoppers cause sporadic but sometimes very severe damage. Some species are vectors of plant diseases so they can seriously decimate a crop when outbreaks occur.

Control to date depends upon the use of pesticides, organized by the Plant Protection Service. There are obvious health and environmental problems associated with excessive use of pesticides in rice sawahs where much hand labor by people standing in the sawah is needed. Host plant resistance to major pests has been studied, particularly by Dr. Pathak at IRRI and some rice varieties show promise of resistance. Survey, scouting and correlation of weather factors with biological data to indicate when and if sprays or other treatment should be applied are areas of research progress just recently being applied to major crops in the United States. Pesticides are applied to rice based largely on the state of maturity of the crop rather than on detailed survey or scouting information, indicating precise pest control needs for most economic and environmental advantage.

Coconut Pests

Coconut is an important Indonesian crop with home consumption being equivalent to 40-50 coconuts per person annually and copra standing second in importance to rubber as an export crop. There are several serious insect pests. Tree climbing long-horned grasshoppers (*Sexava* spp.) do great damage to coconut palms in northern Sulawesi and some of the islands to the north and east. Young hoppers climb the trees and nymphs and adults eat the leaves and young fruits. When damage is severe all leaves and fruit drop from the tree and yields are drastically reduced. For instance, the island of Talaud has a coconut production capacity of 20,000 tons. During a *Sexava* outbreak period around 1970 annual production ran

less than 3,000 tons. With the economy of the island being based on coconut production, this represents a serious problem.

Other Pests

This list could go on through the whole catalog of crop plants, forest trees and particularly the destructive pests of stored products which take a particularly heavy toll of stored grain in most tropical countries. Insects present a serious threat to worldwide food production and in Indonesia the development of a more solid base for training researchers and extension specialists is urgent. Highest priority should be given to the development of high-calibre graduate departments at Gadjah Mada University and Institut Pertanian, Bogor.

APICULTURE

I found no one in Indonesia trained in apiculture. Beekeeping is very undeveloped and the movement of bees to crops for adequate pollination is unknown. Pollination studies in many parts of the world have shown that the presence of bees at blossom time is one of the most critical requirements for production of bee-pollinated crops. I hope that we may soon assist in developing a university program in apiculture.

INDONESIAN LIVESTOCK PRODUCTION

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Domestic livestock serve man as a source of power, meat, milk, eggs, and fiber. Animals that have been widely used by man for domestication are horses, cattle, sheep, swine, and poultry. In the more highly developed industrial countries, livestock production has become specialized. Through selection and management, production per animal of a particular product has been greatly increased when compared with the original undomesticated species.

Modern livestock production has been a development of the last three centuries. Prior to this time livestock production was practiced by nomads. To provide food-stuff, it was necessary to constantly move the herds and flocks resembling the migration of wild species today. With the development of clovers and root crops that could be stored for periods of short supplies, livestock producers quit roaming. About the same time it became possible to own and fence private land, and selection could be practiced. The foregoing observations apply to Europe and North America, but do not reflect development in Africa and Asia.

Probably one more generalization should be made before considering the livestock industry in Indonesia. To have a viable livestock industry there must be a market demand, it must be economically feasible to produce, and we must be able to deliver, or distribute the product.

The Indonesia livestock industry today is perhaps parallel with the U.S. at the close of the Civil War. We depended on livestock as the major source of farm power and this is true in Indonesia today. Livestock products were used by the farm families with surpluses marketed locally. Our transportation system had not developed to the point that we could deliver meat producing animals to a central processing plant, and distribute perishable products to the retailer. We had very little knowledge of feed storage, feed requirements, methods of selection, and livestock management. I think this is the exact status of Indonesia today.

There are some differences between our conditions in 1875 and Indonesia today, and these may be critical. Our population, mostly rural, had a history of meat, milk, and eggs and with the industrial revolution started the ability to buy. Indonesia is largely rural, is probably going into industrial expansion, but for centuries the diet has centered around cereal grains and fruit. Even with the ability

to buy, there may not be the same demand for livestock products. The changing demand in Japan during the past 30 years suggests there can be a rapid change from a cereal diet. Another great difference is the fact that the U.S. has a large land mass and there has never been any real competition between man and livestock, and this becomes the problem so far as Indonesia livestock development is concerned.

I suppose that in the interest of brevity the best way to discuss livestock production is to consider the general subjects of feedstuff, selection, and husbandry, rather than species.

FEEDSTUFF

Indonesia does not have seasons in terms of growing and dormant periods; they have wet and dry periods. For large scale livestock production it would be necessary to store feed for the dry season. At the moment this does not appear feasible due to the limited number of animals per farm. Continuous feed production by irrigation does not appear feasible as land suitable for irrigation is used for rice production.

Indonesia needs to know the best plants for maximum nutrient yield per hectare, the stage of maturity for harvesting maximum nutrient yield and the plants best adapted for harvest and storage.

In general, the few commercial livestock ventures are making use of by-products from food processing and not enough work has been done in this area, and it should be an important source of livestock feed.

SELECTION

Selection for improvement in an economic trait is based entirely on individual records of performance. These data have not been collected, nor has a system of recording been started that would be useful. There is no measure of improved managerial skills unless performance information is available.

HUSBANDRY

There did not appear to be much concern or knowledge of the nutrient requirements of livestock for productive efficiency. Most rations were for meeting maintenance requirements. Fortunately, there is a bulk of knowledge and this is just a matter of education and adapting current principles to the local problems.

I did not observe any local or national programs for the control of livestock diseases and no regulations to govern quality. From a disease standpoint the obvious problem was internal parasites. The tropics and irrigation guarantee this problem.

Reproduction will be a major problem for any type of livestock program. Rates of maturity and reproductive rates would not be acceptable for efficient livestock production.

From my own observation I would be neither optimistic or pessimistic over the increase in livestock production in Indonesia. I have serious doubts whether a decision to increase or decrease livestock production will have any influence on the route taken. If the national policy is to exploit the natural resources by export, the diet will remain mostly cereal. If the policy is to exploit the labor force through industry there will be a demand for livestock products.

The individual Indonesian farmer appears to be capable of livestock production. There is enough technology and specialized farm animals to permit a much more rapid development of a livestock industry than we have experienced.

If there is a trend toward more livestock I would think that the first priority would be poultry, both chicken and ducks for eggs and meat. The second would be swine; although this is not a pork consuming nation, the nation market is, and by-products of food processing can be utilized. Cattle would be the last priority, if mechanics could be substituted for cattle as a source of power, they would have almost immediately a good cattle industry. At least the feed now going for power could produce meat and milk.

SUMMARY

Can Indonesia livestock industry expand? The answer of course is yes. The soil, climate and people could support a livestock industry. The first restriction would be that it cannot expand at the expense of cereal production without drastic social problems. Land not suitable for rice production may be used for livestock. Crop rotation for increased rice production may include crops for livestock feed. A second restriction is the current system of transportation and distribution. The third restriction is a lack of knowledge of production economics.

The economic merit of the current livestock is not good. We are tempted to generalize that they have selected for the worst possible animals. If a large livestock industry does develop there will be a need for a national program of livestock disease control and regulations on quality. The current political structure makes this a formidable problem.

THE FEED SITUATION FOR ANIMAL PRODUCTION
IN INDONESIA

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According to FAO statistics (1970) the per capita supply of meat, milk and eggs in Indonesia was lower than in most other countries in the period 1960-1965. The figures indicated that the daily average food supply for one Indonesian included 11 grams of meat, 1 gram of egg, and 2 grams of milk. More recent Indonesian statistics do not indicate any improvement. It was reported that in 1971 supply per person per day included 9 grams of meat, including poultry, 2 grams of egg, and 3 grams of milk. Two thirds of the milk was imported.

Limited feed supply is the biggest obstacle to increased animal production. Phillips (1966) reported that in Indonesia and other developing countries, poultry meat and egg production per 1000 birds was a small fraction of production obtained in the United States. Whereas North America feeds 79 percent of its total grain production to livestock, the Far East feeds only 6 percent (Catron and McRoberts, 1966).

The FAO Indicative World Plan for Agricultural Development (1970) projected livestock production in 1985 in Asia and the Far East at 9.64 billion dollars (thousand million) compared with 3.55 billion in 1962 and between 4 and 5 billion at present. Demand for cereals for human consumption in Asia and the Far East was predicted to double by 1985, but demand for meat, fish, and eggs was predicted to increase by 250 percent. The plan called for a quick increase in poultry and pig production using "potentially surplus grain" for this purpose. However, the potential grain surplus has not appeared. This means that the demand for grain to feed to livestock and poultry is in competition with the demand for grain for human food. In view of this situation, should we turn our backs on the optimistic Indicative World Plan and go to the other extreme and say that a country like Indonesia should produce and eat no animal products at all, but only plant products?

The answer to that question may be found in the rather large numbers of ruminants and chickens which live in the densely populated villages of Java. The ruminants eat grass which people can't eat, and there are ample possibilities for developing commercial production of ruminants on grassland in Indonesia.

The chickens in the villages forage for themselves and eat left-overs, so they don't compete with the people either. There are possibilities for commercial poultry production based on left-overs.

Table 1 is an attempt to estimate the quantity of cereal grain that is needed to be produced and imported to meet the needs of the human population of Indonesia in 1972. Guesses were made as to quantities diverted to animal feeding. These guesses were based on total production of eggs and on FAO estimates for the Far Eastern region.

If the population of Indonesia needs 23.8 million metric tons of cereal grain per year, anyone attempting to plan self-sufficiency in cereal production would have to set a goal of 23.8 million metric tons for the bad crop years. The recent annual up-swings and down-swings of cereal production have resulted in good years that were 15% better than the bad years so that the goal should project 27.4 million metric tons for the good crop years, an excess of 15 percent over the actual need. Table 2 shows an estimated division of food and feed grain in good and bad crop years and also shows the quantity of grain by-product that would be available. In the bad year, poultry producers would be dependent on grain by-product plus other by-products. In the good year they would have more feed grain than they have ever had yet. Presumably most years would be between these extremes.

You will note that the quantities of cereal proposed in Table 2 are considerably higher than Indonesia has yet produced. These levels are believed to be possible. In 1972 yield of cereal in kg/hectare was 2,122 in Indonesia, 3,899 in the U.S., and 5,497 in Japan.

Table 3 gives estimates of supplies of some by-products in Indonesia. There is production of a considerable quantity of peanut meal and some soybean meal, but peanuts and soybeans are produced primarily for direct consumption rather than for processing, so crop production statistics cannot serve as a basis for estimating by-product supply. Some fish meal is available, made from fish that are unsuitable for human food. Some blood meal is available.

Synthetic vitamins, amino acids, and antibiotics are imported for use in feed. They are considered by the Indonesians to be expensive, but in Indonesia as in the United States, more than 90 percent of the cost of any complete poultry feed is the cost of the calories and protein. Less than 10 percent covers the cost of all the vitamins, minerals, supplementary amino acids and other additives.

In the world of 1975, it will be highly desirable for any nation that has the capability to be self-sufficient in food grains. That means being self-sufficient in the bad years and having a surplus in the good years. Is there any better way to use the surplus than to feed it to an expandable and contractable animal population? To be sure, it could be sold on the world market, but when Indonesia has a good year, the neighbors will probably have a good year, too.

Commercial egg producers in Indonesia will not be happy with the bad year projection in Table 2. I can hear them saying, just as poultry flock owners would say in this country, that chickens will not live and grow and produce eggs if they get only by-products and no grain. However, we have raised pullets from 8 weeks of age to maturity on nothing but rice bran, dehydrated green feed and minerals and vitamins, and they are now laying eggs on such a diet. We don't know yet how well or how long they will continue to lay.

At any rate, the situation represented by Table 2 need be no more than a stepping stone to better things. A country with Indonesia's resources could plan for still higher levels of grain production with a built-in feed grain component. Let's not forget, though, that the levels of production shown in Table 2 are still to be achieved.

Food and Agriculture Organization, 1970. The State of Food and Agriculture.

Phillips, R.W., 1966. Animal Agriculture in Asia - Present and Future. Proc. 15th Annual Meeting, Agr. Research Institute, 147-178.

Catron, D.V. and M.R. McRoberts, 1966. Animal Proteins in the Diets of the World's People. Proc. 15th Annual Meeting, Agr. Research Institute, 45-64.

Food and Agriculture Organization, 1970. A Strategy for Plenty. The Indicative World Plan for Agricultural Development.

Food and Agriculture Organization, 1973. FAO Production Yearbook, 1972.

Table 1

INDONESIAN PRODUCTION AND UTILIZATION OF CEREAL GRAINS, 1972

	<u>Metric tons x 10⁶</u>
Cereal production	21.716
Net imports over exports	<u>2.445</u>
Total	24.161
Estimated cereal for human food	23.761
" " for poultry	.200
" " for other livestock	<u>.200</u>
Total	24.161

Table 2

WHAT GOALS FOR CEREAL PRODUCTION IN INDONESIA?
(People needed 23.8 million metric tons, 1972)

	<u>Good year MT x 10⁶</u>	<u>Bad year MT x 10⁶</u>
Projected cereal production	27.4	23.8
Cereal for food	23.8	23.8
Cereal for feed	3.6	0.0
Cereal by-products for feed (9%)	2.5	2.1
Total feed	6.1	2.1

Table 3

SUPPLIES OF BY-PRODUCTS, INDONESIA

	<u>MT x 10⁶</u>
Rice bran and polish	1.90
Copra meal	0.36
Cottonseed meal	0.002
By-product molasses	0.53
Peanut meal	?
Soybean meal	?

ASSESSMENT OF ANIMAL DISEASE PROBLEMS IN INDONESIA -
CURRENT AND FUTURE

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It is difficult to make an accurate assessment of animal disease problems in Indonesia. There is no question, however, that animals in Indonesia are affected by a wide range of infectious and noninfectious diseases and that many of these diseases are hazards to human health. Parasitism is especially severe. Fascioliasis (liver flukes) and trichostrongylosis (stomach worms) of cattle, goats and sheep are major problems. Surra (trypanosomias) of cattle, buffalo and horses and coccidiosis in poultry are also serious. One of the most devastating diseases is Newcastle disease in chickens. In some years approximately fifty percent of the chickens have died from this disease. Hemorrhagic septicemia (pasteurellosis) is important especially in cattle and buffalo. Major diseases of animals which also have public health significance include rabies, foot and mouth disease, anthrax, brucellosis and salmonellosis.

Figures are highly variable on the extent of losses from animal diseases. An Indonesian Government report in 1967 (Hasil Survey Inventarisasi Hewan) listed annual losses of approximately 17.6 billion rupiahs. In Dr. Bryan's report he indicated that Mansjoer (1971) estimated losses of 240 billion rupiahs from parasitism alone. Losses were estimated at 6.5 million dollars for anthrax, 14 million for rabies, 18 million for foot and mouth diseases, 30 million for brucellosis and 200 million for salmonellosis.

We can better understand the uncertainty regarding animal disease losses by reviewing the 1972-1973 national order of priorities for animal disease control. Of the ten listed priorities, five were related to surveys to determine the extent of particular problems. Listed third was the need to set up diagnostic laboratories. Certainly the priority list points up the desire and the need for more information. Without adequate and easily accessible diagnostic facilities, definitive diagnoses are impossible with many diseases. Without surveys and comprehensive testing programs for such diseases as brucellosis, tuberculosis and leptospirosis it is nearly impossible to assess the economic losses.

It would be possible to control and possibly eradicate many of the animal diseases if a well funded and organized federal program for disease control were undertaken. Such a program requires more funds, facilities and personnel for animal disease research. Although some research is being done at places such as IPB, UGM, the Animal Disease Research Institute at Bogor and the Institute for Virus Diseases at Surabaya, much more is needed.

A disease control program also requires more comprehensive testing and vaccination programs. Such programs require laboratory facilities, adequate testing reagents and dependable and readily available vaccines. Although vaccines are being produced at Bogor and Surabaya, more are needed.

Losses from many of the parasitic and bacterial diseases could be reduced considerably if medicines were readily available to the veterinary service and to the animal owners.

Future success in control of animal diseases depends to a great extent on fulfilling the needs I have pointed out. I was encouraged by several developments. The Australian government and the Province of Bali are cooperating in a vaccination program to control and eradicate foot and mouth disease in Bali. Success of this program should encourage similar cooperative efforts.

I was also encouraged by the increased production of vaccines and therapeutic agents at the Institutes at Bogor and Surabaya. Another encouraging development is the construction, equipping and staffing of research and diagnostic laboratories on Bali and Sulawesi. This effort is co-sponsored by the United Nations and by the respective provinces. The laboratories should be valuable in the diagnosis and control of disease and in the training of veterinarians for work in this field.

I believe another important evidence of progress is the increasing number of veterinarians who have undertaken graduate programs with MUCIA and other support. Many of these veterinarians have now had experience in research and diagnostic laboratories and will be invaluable in future work on animal diseases.

In summary, animal diseases cause extensive losses in Indonesia and it will take considerable funds, organization and effort to effectively control these diseases.

THE NEED FOR AN AGRICULTURAL MECHANIZATION POLICY IN INDONESIA

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Well, it's certainly a pleasure to have an opportunity to share some of my thoughts with you here at the seminar. As Dr. Wyeth said, I was in Indonesia for three months, so I feel just a little bit humble about my expertise as far as Indonesia is concerned. The comments that I'm going to make today are really not just for Indonesia but more of an expression of philosophy, and some ideas that I have about mechanization in any country, and I think certainly that some of the comments will be relevant to Indonesia.

What I'd like to do is philosophize just a little bit about mechanization, then I'd like to talk a little bit about mechanization as what I call a hope for farmers, and then talk specifically about how to make mechanization work. That's where we get to the question of policy. It's my contention that if any country wants to make mechanization work, it must have a coherent and consistent set of policies to make it function. And I have never seen a country anywhere, including the United States, I guess, that has what I would call a coherent and consistent mechanization policy.

Before I go any further, let me define mechanization, so that we're all talking about the same thing. I use the term broadly - anything mechanical in nature, such as hand tools, animal implements, tractors, water pumps, sprayers, and so on. I think it makes sense to do this, because there are certain commonalities with all of those levels of mechanization - most of them involve metals and certain mechanical skills to operate, and while it's true that it's a whole lot different to operate a tractor than it is a hoe, still they are both mechanical devices, and it's a matter of level and degree to make them work. So if you accept my definition of mechanization, then you'd have to agree with me that mechanization exists in every country, and the real issue that we're here to discuss is at what level it should exist for a particular country. And then, how can the benefits from mechanization, whatever the level, be maximized, and how can any negative aspects be minimized. Those are the kinds of questions, it seems to me, that we should be addressing.

Now, we all talk a lot about what has become known as selective mechanization. The point that we're talking about here is simply using the right tool or machine at the right time and in the right place. If the field is only one-tenth of a hectare, probably a tractor is not the right thing. If you don't have the trained personnel, certainly higher levels of mechanization are out of order. So, selective mechanization simply means selecting the right tool, the right piece of equipment for the right job. And this involves not only technical considerations from an engineering point of view, but it involves agronomic considerations and economic, social and other factors. You might consider it as kind of looking at the whole picture and coming up with something that fits. Now part of my philosophy of mechanization takes me a little out of my field, perhaps, as an agricultural engineer, but brings me to the question of what we are talking about when we say that we want to work with countries to help them develop. We always hear people talking about development. Now, what is development? Well, you can have your definition; my definition is that we're talking about a process that leads to an increase in production per person. It seems to me that this kind of a long-term increase in productivity is necessary if we're going to have increases in the standard of living, which to me is development. So I'll refer back to that several times as we go along, because I think that selective use of tools and machines can be a key to use in the development process.

By way of introduction here, many people have pointed out the problems associated with mechanization and I'm not going to dwell on them here today. May I just mention that I'm aware that we're talking about countries where tillable land is often scarce; in parts of Indonesia it's very scarce, in other parts it's not so scarce, so it's hard to generalize, but certainly I'm aware that if you go to higher levels of mechanization, field sizes would become relevant. Capital availability must be considered, since higher forms of mechanization are expensive, and require a considerable investment; this can well be a problem. The employment issue is another concern. I'm going to refer to that more as I go along, but certainly we are well aware that in Indonesia and virtually every developing country there are employment problems. Will mechanization make them better or will mechanization make them worse? Many people jump to the conclusion that higher forms of mechanization will automatically aggravate the employment problem. I think it's a more complicated issue than that really, and I'll dwell on this a bit

agriculture? Rural poverty may be less miserable than urban poverty, and perhaps the danger of starvation is less in the rural areas, but what hope is there of improving one's situation? Once a young person from a rural area has seen the city, he isn't satisfied to slave desperately the rest of his life to eke out a meager subsistence by hand, or even by animal power. He feels inclined to migrate to the city, where there is hope, though perhaps false hope, that he may be the one who gets one of those few jobs in the city. So I say again, selective mechanization can provide a hope for farmers, a counter-pull, if you will, to help draw some of them back to the rural areas. And I'm not willing to say, "Well, they can't afford it, it's too complicated, it won't work, so don't let them try."

So this leads me then to the issue of how to make it work. If you agree with my ideas that there may be forms of mechanization that would be desirable in every country, and there is a desirability of moving to higher levels of mechanization, how do you make it work? Well, here's where we get to mechanization policy. It seems to me that to make it work, you have to have a broad set of policies that deal with the various issues involved. I've broken the issues into three broad categories, technical, economic and social ones, and I'd like to comment very briefly here for the next five minutes or so about some of the components of a mechanization policy that I think all governments, including Indonesia, should adopt in order to make it work. I want to lead off by repeating and reemphasizing some of the things that I said here before. The main question is, "What goal or objective is it that we're after?" And I answer with three questions, "If a higher level of living for all the people is sought, does this not require increased production per person?" "Is the goal total employment of all the people who are able to work, even if it's nearly at the starvation level?" "Is there some optimum allocation of limited jobs, allowing some unemployment where production and individual income, and thus the level of living, is maximized for the greatest number of people?" Well, these comments just focus on the employment end of the problem.

Now, I would point out that the absence of an explicit mechanization policy is a policy in itself. It's a policy to flounder; it's a policy to waste limited resources, by purchasing part of the input but not developing enough of the essential parts to make it work. And I see this not only in Indonesia but I've seen it in many countries, and of course, the conclusion that many persons draw

is that mechanization is bad; mechanization doesn't work; it has no place or at best a minimal place in a developing country. However, I say not necessarily, because really the problem is that a coherent set of policies has not been implemented to make it work.

Let's discuss what some of these policies are. The first is concerned with the interrelationship between mechanization and other inputs. A tool or implement is just something to make life easier for people, and not an end in itself. It is just one of many inputs. If higher forms of mechanization are to have any benefit at all, they're going to have to be coupled with all the things you know so much about, such as the seeds, the fertilizers, the water control, and so on. But certainly we would, as our first component of policy, say that all the inputs would have to be brought together in the right combination in order to benefit from their use, and mechanization is one of them.

The second policy component, under what I've labeled technical considerations, is the area of trained personnel, at many levels. Mechanization systems, especially when you get into engine power, are pretty complex. It requires many different kinds of trained people, such as operators, mechanics, foremen, planners, design engineers, and a lot of others. And so to make mechanization work, policies are going to have to be implemented to be sure that you have the necessary skills to get the job done.

Now, the next technical policy component that I want to mention, and this one applies primarily to the higher levels of mechanization, would be the dealer system. Dealers in the United States and in developed countries provide the spare parts and the service expertise to keep the system going. Similarly, in a developing country, it seems to me that some form of dealer system needs to be encouraged. Policies need to be implemented that will give dealers a chance to develop. These range broadly from controlling the density of machines at such a level that the dealer can operate profitably to permitting import of spare parts or encouraging their manufacture by local industry, and lots of other things that need to be thought about.

Another policy component which takes on greater importance today than ever before is the fuel supply. If you're going to have higher levels of mechanization the fuels are going to have to be there, and this one brings up a whole set of issues in itself because of the higher prices and the current dynamic fuel situation.

The present situation makes it that much more difficult than ever before to justify a tractorized mechanization system.

Then there's the issue of whether government should encourage domestic manufacture, or whether tools and machines should be imported. All I will say at this point is that there is an argument for both. There's probably a place for both, for certainly at the lower levels of mechanization, hand tools and animal implements can usually be manufactured locally. Even the more sophisticated tools and machines and even tractors in some countries, and some situations, may be manufactured locally. However, every country seems to want to do it all at home, and this creates some problems, because of quality of components, manufacturing abilities and these sorts of things. In developing policy one does have to be careful when you get into the higher levels of machines.

Let's skip over to the next policy component that I believe is necessary, and one which affects the people that I worked with in Indonesia probably as much as any of these I have mentioned. I refer to research, development and testing. It's my observation that the agricultural engineering departments in ministries and universities of most countries in the world receive something close to the lowest priority within the system. Certainly the laboratories, the facilities and the emphasis for having people that get the job done, fall short. I'm not criticizing anybody in particular but I'm just saying that a research program, a development program, or a testing program, are important parts of a mechanization policy, and I think if the government is going to make mechanization work, sufficient emphasis is going to have to be given to that phase of the overall program.

So much for technical things; I think you get the point, and I hope I make it clear that it takes a lot of things to make a mechanization system work, if you're talking about anything above an indigenously made hand tool. Above that, you must consider developing a blacksmith system, and beyond that a manufacturing system. Then you're talking about having metals and components available, repair parts, and all that, to make the system work.

Now let's get over into an area in which I admit I'm out of my field, because I'm not an economist. But I'd like to just mention some economic points here, and the first one I would say deals with the cost-benefit ratio. I don't think we really know, in most countries, what we're talking about in terms of cost-benefit ratios with respect to mechanization. There have been lots of studies, but I don't

really think we have a clear picture on whether we're getting a net gain or loss from using a particular tool or machine system. And I would just emphasize here that it gets very complicated because we're not talking about just the farmer costs or the direct costs. Many people who have thought about this ratio conclude that the problem with mechanization is that, although it's profitable to the farmer, if you look at the net social costs to the country, it's negative. Lots of people have taken this view, in writing. Well, I think it's still an open question myself, but I would admit that neither side in the controversy has really enough good data to make an absolutely air-tight case for its point of view. So certainly then governments that are going to make mechanization work, at whatever level, need to have a clear picture of the cost-benefit ratios of mechanization. This would apply if the decision is to stay with hand tools and/or animal implements, or to move to higher forms of machines. If Indonesia decides to stay largely with hand tools in an attempt to provide more employment opportunities for rural people, then sufficient information should be gathered to see if the cost-benefit ratios warrant this choice over increased emphasis on mechanization. Government policy regarding hand tools and animal implements appears to be favored, though official views in written form are difficult to find.

Now I would like to discuss the issue of income distribution. A lot of people have made studies, written, and argued that higher forms of mechanization may be alright but they benefit just a few people. I think there are certainly some examples where this is the case. I'm not going to stand up and argue whether it is or not, but if so, I think this is not a good situation. Policies do need to be devised that will help spread the income as well as one rationally can. Other rather obvious components of policy related to economics would be, and I'm hitting them pretty superficially, credit, and the use of subsidies or tariffs or taxes to either encourage or discourage mechanization. Any time we go beyond a hand tool, we're probably talking about some kind of credit system to make it possible. What I'm saying is that in many countries that I've worked in, and from what I saw in Indonesia, this whole set of policies really hasn't been thought out. It's much too haphazard, and consequently the probability of success of any higher level of mechanization scheme is not very great in my opinion.

Another economic consideration is the marketing system. We assume that if our goal is to increase production that a market exists to absorb the additional

product. Stated another way, we assume that something is going to be done with that product when we get it produced, and that some kind of means or system is available to get the product from the source of production to a market. This may or may not be a valid assumption. Transportation systems and storage systems have engineering implications, and these aspects are grossly inadequate in many countries including Indonesia.

The last group of policy considerations that I would mention would be the social ones, which I think I've already mentioned. To this point I would just say that as an engineer, I plead guilty to some lack of concern for the social effects of some of the mechanistic approaches that my profession has been responsible for. I think the attitude on this among engineers is changing. I would quote my engineering colleague at Ohio State University, Byron Bonderant, who wrote in a paper: "How long will engineers be content merely to develop systems to implement scientific advances rather than to design systems for the need of a particular social and cultural situation?" And I think his concern is, like many of ours, that we have been too hardware-oriented. We've said, "Let the sociologists worry about employment or whatever." Now that has changed and there are many engineers who are now reading, studying, thinking and concerning themselves with such things as employment issues.

I have a little bias I'd like to share with you on the employment question, and it refers to the statement I made earlier, "What is our goal?" If the goal is to produce a job or have a job for everyone, regardless of the specialization or level, then it seems to me that agriculture bears more than its share of the employment burden; I know most of the people are in agriculture, but if we really want to maximize the number of jobs, I would suggest we throw away all the adding machines in the bank, get rid of those concrete mixers that you see being used when they're building roads, and let's even do away with a lot of the transport. Because if jobs are the only goal, regardless of the level, then we can create more jobs. But don't just look at agricultural mechanization and say "That's bad, get rid of it, don't let it in, because it might put somebody out of work." Remember that there's another side to that story, which points out that mechanization can be a hope for farmers; it can help keep them where we want them to stay by giving them something to look forward to some time down the road.

I think these are the main points that I wanted to make today, at this seminar. I anticipate that I'll have some questions about my kinds of philosophies. Certainly there's room for a number of points of view. But the concern I would leave with you is that mechanization systems are complex, especially at the higher levels. They're not going to work by themselves; they're not going to work and be successful, economical, practical and good for the country unless a set of strategies are carefully planned to make them work. And that's true anywhere in the world, and certainly true in Indonesia.

WATER RESOURCE PROBLEMS IN INDONESIA

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I am happy to have the opportunity of attending this Seminar on Indonesian Agricultural Development and to share a few thoughts with you pertaining to water resource management. It is often stated that Indonesia is a nation of many natural resources. When such a statement is made I am sure most of us associate these resources in terms of petroleum, numerous deposits of metals, timber and various others. We are often prone to overlook the fact that perhaps Indonesia's greatest resources are its soils and its water supply. Since Dr. Kirk Lawton gave us a fine overview of Indonesia's soil resources in his paper this morning, I will direct my remarks toward water resources and try to indicate how I feel they might be managed and used. Having spent but three months in Indonesia, during the early part of 1972, I was able to see but a very small fraction of their total water resource situation. It is for this reason that I have indicated a desire to share thoughts with you, rather than to attempt to make definite recommendations. Furthermore, as a preface to my comments, it should be recognized that my stay in Indonesia was spent entirely on the island of Java where water management and practices are very intense and well established. The greatest benefits for most of the recommendations to follow can be derived through their application to problems in the outer islands where agricultural practices are less intensely established.

It has been suggested to us by several of the earlier speakers that agricultural development and production involves a very complex system, involving factors ranging from water, soils and climate, to politics and religion. I am sure we would all agree that water must be placed high on the priority list in any agricultural development program, since without water all life ceases.

Collection of Hydrologic Data

In my judgment one of the most essential facets of any water resource development plan is that of obtaining a knowledge or inventory of the available water supply. A hydrological data base defining such characteristics of precipitation as storm intensity, frequency and amount, is indispensable. Knowledge of the

timing of various flood flows in rivers, together with the amount of water available in lakes, reservoirs and groundwater aquifers is also important. Reliable decisions on water management are impossible without knowledge as to when and where water is available, and also of the general nature of its occurrence.

Some such needed hydrologic data have been accumulated at selected points in Indonesia and are generally available. Unfortunately, except for a few locations, uninterrupted records of good length appear to be scarce. It is usually assumed that at least 20 years of rainfall record at a given station is necessary to obtain a fairly accurate estimate of long-term means. Such a 20-year record makes it possible to estimate long-term mean values within a 3.3 percent error, which is near enough for most practical purposes. Obviously, engineers and scientists like to have as much and as many different types of data as possible on which to base their planning decisions. As with most programs, however, cost becomes a limiting factor in hydrologic data collection and as a result only certain types of data are obtained. Many hydrologists feel that where limited data are to be collected, daily temperature and daily rainfall observations are most useful. On this basis perhaps at most stations the data collected could be limited to these two phenomena in order to minimize cost. Only simple equipment in the form of maximum-minimum thermometers and non-recording rain gauges would be needed to obtain such data. A few selected stations, however, should be equipped with recording rain gauges to obtain data on storm intensities, which are indispensable in predicting flood flows from any given area. Recording-type equipment is more costly, however, and also more difficult to maintain.

While the value of hydrologic data is generally recognized by the average engineer or scientist in Indonesia, obtaining the data often seems difficult. There is evidence to suggest that in some cases instruments such as rain gauges, etc., are not presently being used to their full extent because of relatively minor deficiencies of spare parts or other malfunctions. A concentrated effort directed toward the servicing of equipment so impaired would greatly increase data collection capability in Indonesia.

Insofar as facilities and competent personnel are available, measurements should also be made of flow in major streams although such measurements may be possible only at diversion dams and other major control points along a stream. Some measurements of this type are currently being made.

One of the most difficult problems encountered in the collection of hydrologic data, assuming the desired measurement equipment has been acquired, is that of selecting people who can be assigned the responsibility of seeing that uninterrupted and accurate data are taken. Although it is not always possible, this can best be accomplished by assigning the responsibility to someone who has some interest in, and recognizes the importance of, such data. I can think of no better alternative in Indonesia than to select a dependable and interested staff member at each of the non-Pembina institutions and give him the responsibility of collecting the desired data at his particular location. If possible, staff members so selected should be permitted to attend an instructional short-course at either IPB or Gadjah Mada, where he could become familiar with the equipment, indoctrinated as to what his responsibilities would be, and learn how the equipment should be maintained and serviced.

Groundwater Inventory and Use

Another facet of the total water resource development picture to which I would like to see some effort and attention directed, is that of the inventory and use of groundwater supplies for agriculture. During my brief visit in Indonesia I saw some wells but they were mostly dug-wells, relatively shallow in depth, and were being pumped by various types of primitive lifting devices to provide domestic water supplies within the immediate village areas. Informal questioning of some of my engineering counterparts in Indonesia suggests that groundwater is not used extensively for irrigation, nor were they aware of any extensive groundwater surveys having been made in most areas.

As was pointed out in one of yesterday's presentations, the Indonesian farmer is subject to seasonal or even daily variations in stream flow because little or no surface storage has been planned for in the system. It is logical to assume that in many parts of Indonesia groundwater supplies for irrigation could be developed at minimum cost. Since for centuries water has been pumped by hand in Indonesia, using very primitive methods, it is little wonder that water supplies obtained by gravity flow have retained their popularity. You may argue that to pump water from a well would require power and energy far beyond the capability of the Indonesian farmer. While this is true, it seems that this might be a situation where the government could make good use of Indonesian oil, and other sources of energy, to provide power for pumping irrigation water.

The best engineering and scientific minds of the world are often used to construct major dams to provide water for the irrigation of arid lands. Unfortunately, such major structures receive all of the attention because of their immensity and glamor. The amount of water stored in the reservoirs of such projects, and available for irrigation, is small compared to that stored in most underground aquifers. Hence, using groundwater for irrigation does not require large expenditures of funds, presents little or no safety hazard, and often taps a reserve supply for use during dry periods. Although an irrigation well, no matter how much water it produces, isn't particularly glamorous for the designing engineers or politicians, a few such wells would be capable of irrigating many hectares of Indonesian land. Such systems would not occupy large acreages of productive land now being occupied by large and far-reaching canal systems.

Management of Water

The third facet of water resource development in Indonesia that appears in need of attention is that of managing the water more efficiently. Obtaining better water-use efficiency is a problem everywhere - not just in Indonesia. The problem seems particularly difficult in Indonesia, however, because of the lack of communication that exists between the government official making the decisions and the farmer applying the water to the soil. Again, it is ironic that the best scientific minds are used to construct the major features of water supply projects (dams, canals, etc.) but the actual application of the water to the soil is left to the farmer. It is often assumed that so long as the water is delivered to the edges of the field all the problems have been solved, when actually they have only begun.

Management of Natural Rainfall

Where does water management begin? It can, and should, begin as soon as the water strikes the soil in the form of precipitation. Complete management of natural rainfall minimizes runoff, evaporation, and water consumption by unwanted vegetation in order that more water can be utilized where it falls for crop production. Surface runoff of water following heavy rains is a very serious problem in Indonesia, not only because of the loss of water to that particular crop land but also because of the soil erosion damage which occurs. If more rainfall can be stored and utilized where it falls, less will be needed as irrigation. In parts of Indonesia, as is true in many developing countries having high population

densities, a considerable amount of land is farmed on excessive slopes, and other land that should not be farmed. Such practice often exposes soil to the erosive action during the more intensive storms. While it is recognized that with the very intensive rainfall and steep land situation in Indonesia surface runoff cannot be eliminated entirely, water management practices to reduce runoff should be emphasized. These practices include cropping cover, contour farming, contour furrows, strip cropping and crop residue mulching, in addition to the finely developed art of terracing already evident throughout much of Indonesia.

Management of Irrigation Water

Except for a very small percentage, agricultural production in Indonesia is derived from small farms, being farmed today in the same manner as they were centuries ago. As you know, farmers on these small holdings barely eke out a subsistence. While I am sure we can all agree that these small farms are not economical, they will still be there for generations to come simply because the rural people in Indonesia have no alternative, except possibly to move into Jakarta or some other major city. Unfortunately such farm migrants are not qualified for the few industrial jobs available in the city and as you know end up in unbelievable poverty in ghetto areas.

Such migration from the country to the ghetto areas of the cities will continue to increase unless it can be slowed down by making life in the rural areas more tolerable. Rural people must increase their standard of living through increased productivity. Since I am not an economist I will not attempt to bore you with my suggestions for solutions to the problem, except to point out that one possible way of increasing productivity in the rural areas is to increase farm production through more efficient on-the-farm water management. The motto - "let no man waste a drop of water that another man may turn into bread" - holds in Indonesia as it does everywhere else in the world.

Provided it is properly managed, irrigated water optimizes all the production inputs in the agricultural production system. On-farm management of irrigation water is complex due partly to the fact that irrigation usually involves a community effort. Where a joint effort is required to construct the needed irrigation works, the facilities are usually shared and the individual farmer is not always able to make his own decisions.

Through the process of trial and error over many years, the Indonesian farmer has developed an irrigation method that works well for the particular plot of land he is cultivating. All methods of irrigation, however, can be improved with input of recent technological advances. For example, a farmer can level his land by the trial and error method but in doing so it will be many years before he is able to obtain benefits of having his land level, such as more uniform application of water, more efficient use of the water, more uniform stands of crop, less weeds, better utilization of fertilizer, and increased yields. While the above land leveling example may not apply to much of the cultivated land on the island of Java, since land holdings are generally small and already leveled, the trial and error method of leveling should be avoided as much as possible on some of the more open outer islands.

As in most developing countries, the most basic and difficult problem in water management is that of finding ways of getting the peasant-farmer to adapt to modern technology advances. We might argue that the traditional Indonesian farmer, through trial and error, already knows more about such things than we can ever hope to tell him. This may be true for the knowledge and technology he has at his command. However, additional technology requires changes and adaptations of which the native farmer is completely unaware. The typical Indonesian farmer is likely not aware or even concerned about the interactions that water may have on his yields. He is interested mainly in the quality and amount of rice or other produce available for his use or for market, for that is what he sees. As far as he is concerned water, soil, fertilizer, climate, crop, irrigation method and all other growth factors are simply the means to the end. The job of getting information and technology to the small farmer must be done in a subtle manner so that he can be led to the right decisions. Admittedly, this is not any easy task, and could likely best be done by an Indonesian "extension worker" rather than a person of foreign descent. Unfortunately, however, it may be found that an Indonesian having sufficient education and training to do the job of bringing new water-management technology to the farmer has very likely had no farm experience himself. Such lack of farm experience by the educated is a world-wide problem in developing countries and again is not applicable to Indonesia alone. Any country with an agricultural research program must have an extension service to take the new information and recommendations to the farmer.

IMPROVEMENT OF FOOD PROCESSING
UTILIZING MICROBIOLOGICAL PRINCIPLES

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The movement of large populations of people from rural to urban environments requires dramatic changes in food processing and distribution procedures. In rural areas, particularly in tropical climates, food can be consumed soon after harvest, and the traditional processing methods used are devised primarily to increase acceptability of the food; and in many cases, there is little or no extension of the period of time the food is preserved. In contrast, in large urban areas it is essential that foods be preserved for extended periods to allow for distribution, and to make seasonal food crops available throughout the year. Fortunately, rice is fairly easily preserved by drying. However, the population in Indonesia is increasing more rapidly than the yield of rice. Other foods must be produced and preserved to feed the rapidly urbanizing population.

The development of large food processing plants in Indonesia at the present has some very severe limitations. The problems of production and collection of a given food crop for processing are accentuated by the small land holdings of farmers. The relatively low standard of living of the populace places a severe limitation on processing and distributing costs. The shortage of electrical power and the lack of refrigeration restrict the types of processing that can be used. Finally, consumer acceptance of Western-style processed foods is a serious consideration. Therefore, any immediate steps to relieve the food shortage by processing might best be in the direction of improving existing processes to increase the general quality and nutritive value of the foods, and to greatly extend shelf-life. Developments of this type could lead to small village-level food processing industries which would increase the income of the farmer and provide employment for village residents.

Microorganisms are in a constant race with man for the consumption of food. Therefore, to preserve foods we must either inhibit the development of microbes or kill those present which could spoil the food and package the food in such a way as to prevent recontamination. General time-tested processes developed to

inhibit microorganisms are refrigeration, drying, salting, smoking, fermenting, addition of chemical preservatives, and combinations of these. Food processes designed to destroy spoilage microorganisms are canning and irradiation. It is obvious that we cannot rely on refrigeration, canning or irradiation in Indonesia today for reasons outlined above. However, the other types of processes are all practical and practiced in that country today, but the efficiency of the processes in use could be greatly improved.

Table 1 presents a summary of the traditional processed foods in Indonesia according to a paper prepared by F.G. Winarno, Srikanth Fardiaz, and Djundjung Daulay, Bogor Agricultural University (1973). As indicated, any preservation achieved by these processes results from the addition of high levels of salt or sugar or from dehydration. The drying process used depends on solar energy which is not very efficient or dependable. Also, the relative humidity in Indonesia is high and many dehydrated foods are very susceptible to spoilage by molds unless they are protected from the atmosphere. Therefore, dehydrated foods are not very stable. High salt levels alone or combined with dehydration will extend the shelf-life greatly, but the product cannot be consumed in any great quantity unless desalted.

Table 1
TRADITIONAL INDONESIAN PROCESSED FOODS

NAME	PRESERVATION	
	PRINCIPLE	TIME
IKAN ASIN (salted fish)	20-30% NaCl + drying	6 months
PETIS (fish/shrimp extract)	50% sugar	?
KERUPUK (shrimp/fish chip)	drying	?
DENDENG (dried meat)	drying	?
SALTED EGG	salt	2 months
PINDANG EGG	boiled	1 week
TAHU (soybean curd)	extract	1 day
COPRA (dried coconut)	drying	?
GAPLEX (dried cassava) (must soak to remove cyanide)	drying	?
PISANG SALE (dried banana)	drying	?

Some fermented foods common in Indonesia are listed in Table 2. These fermentations are designed to produce a new food product rather than to preserve the food. All of the products listed in Table 2 have a very short shelf-life (1 to 2 days) except for ketjap which is a condiment.

Table 2
INDONESIAN FERMENTED FOODS

NAMES	DESCRIPTION
TAPE AND TAPE KETAM	FERMENTED CASSAVA AND RICE: FUNGAL FERMENTATION PLUS ALCOHOLIC
TEMPE	MOLD RIPENED SOYBEAN CAKE
ONTJOM	MOLD RIPENED PEANUT CAKE
TERASI	FERMENTED SEAFOOD CAKE: HIGH IN SALT
KETJAP	SOY SAUCE; BLACK SOYBEANS FERMENTED WITH FUNGI

Now for the real question: What can be done to develop stable processed foods in Indonesia? It is well known to microbiologists and food technologists that the development of a process for preserving a food must be based on a complete understanding of all the chemical, physical and biological factors involved. Chemical reactions, both nonenzymatic and enzymatic, may spoil a food otherwise well preserved from microbial attack. Physical changes in the texture of the food may result in nonacceptability. Finally, the types of microbes which can grow on the food under a given set of conditions are greatly dependent on both the chemical and physical factors. Frequently, a combination of processing methods is more efficient in preserving a food than is a single procedure. For these reasons, we must study all of the parameters of a given food product to develop new methods of processing.

Of the processed foods in Indonesia, I am most familiar with tempe, a mold-ripened soybean product. This product is sold widely and is widely accepted. Its nutritional value is quite high, and soybean production could be increased greatly without great difficulty. Tempe is not a preserved food; it becomes nonacceptable within 1 or 2 days after ripening. Therefore, tempe must be distributed and consumed quickly in the area in which it is produced. One

backyard tempe factory which I visited produced about one-half ton of tempe per day, using very primitive methods under very unsanitary conditions. Tempe produced in this manner is a public health hazard not only because it may be contaminated with pathogenic bacteria but also because it may contain mycotoxins (potent carcinogens).

Many things which would improve tempe production could be accomplished immediately. A controlled inoculum could be produced, processing procedures could be developed for increasing efficiency, and reasonable sanitary practices instituted. However, for maximum development of this industry, procedures must be devised for preserving the ripened product. This would take a little longer to accomplish. Careful biochemical, microbiological and physiochemical studies should be made of the entire process and the product. Then various preservation processes and combinations of processes such as heating, drying, salting and adding chemical preservatives could be outlined and tested. It is quite likely that such studies would prove fruitful not only with tempe but with other traditional foods in Indonesia.

In the long range, it would appear quite feasible to develop more concentrated food processing industries and to develop new food products which would gain acceptance in Indonesia. Population pressures may make it necessary to produce "single-cell protein" (microbial protein) from various substrates for use as food by man and/or animals. This can be readily accomplished from such substrates as sorghum and it may be feasible to produce such protein from a variety of waste organic material such as rice straw. Research should be underway in this area now, because it will require considerable time for development.

The mushroom industry on the Dieng Plateau is a model food production and processing industry in Indonesia. A waste product, rice straw, is used to produce a valuable food. The mushrooms are harvested and canned under very sanitary conditions in a scientific manner. Unfortunately, the product is too expensive for the average market in Indonesia, but it is in demand for export. There is still much that could be done to assist and expand this industry. The construction of a good road from Wonosobo to Dieng would be very helpful since the rice straw must be trucked up the mountain. Microbiologists could be helpful in developing a laboratory to produce the pure cultures of Agaricus campestris which are used as the primary inocula. These are presently purchased from Europe and Taiwan.

I see no reason why this industry could not be expanded tenfold if given the proper support.

In summary, I suggest that the attention of microbiologists and food scientists be directed toward the improvement of traditional processed foods in Indonesia. Efforts should be made not only to improve processing methods and sanitation, but to devise processes for their preservation. This should lead to the development of village industries. At the same time, research programs should be directed toward the development of commercial scale food processing industries to produce food for both domestic and foreign consumption. It appears that the conversion of plant material to single cell protein will be necessary in the near future if we are to feed the burgeoning population. Agricultural specialists must identify the crops that could be most efficiently produced for this; the microbiologist must develop the processes for the conversion; and the food scientist must devise processes to make these excellent protein sources acceptable for consumption.

PROBLEMS AND POTENTIALS ASSOCIATED WITH DEVELOPMENT
OF FORESTRY IN INDONESIA

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1. INTRODUCTION

Indonesia has one of the largest and most important forest reserves in the world. Much of this reserve is virgin forest virtually untouched. On the other hand, most of the paper used in Indonesia, most matches, practically all hardboard, plywood, etc., must be imported. Farmers are constantly searching for firewood to cook their meals.

The reasons for this discrepancy are:

- The heavy concentration of the Indonesian population on the island of Java, which has relatively little forest land, while the large rain forests are located on the outer islands like Borneo, and West Irian (New West Guinea). These areas are very sparsely populated.
- Lack of industrial development for domestic production of the more sophisticated forest products.

These circumstances result in the exportation of logs and the importation of manufactured wood products. This condition is typical of an underdeveloped country.

Next to oil, timber is the most important resource of Indonesia. The developing timber industry is expected, by reversing this situation, to contribute to the reduction of unemployment in Indonesia.

2. FOREST RESOURCES AND THEIR UTILIZATION

All forest land in Indonesia is owned by the government and is managed by the National Forest Service. The Forest Service is not limited to the management function, however, but also operates sawmills, preservation plants and other facilities. It also controls the entire teak trade. The most significant resources at the present time are:

- The teak forests of East and Central Java.
- The rain forests of East Borneo.

The Teak Forests

There are a total of 4 million acres of teak forests in Central and East Java of which 2 million acres are productive, mostly plantations. The rotation is between 80 and 100 years and the annual cut is about 112 million board feet, log scale. Harvesting occurs by clearcutting, regeneration by direct planting of seed. The teak stands seem to be well managed except for the curious practice of girdling the mature tree for the purpose of drying it on the stump for up to two years. The total teak export in 1972 was only 5 million board feet, mostly to Asia and mostly in log form. While there exist a number of mechanized sawmills, generally employing a single blade frame saw, for the conversion of teak logs to lumber, most of the lumber is produced in manual sawmills. There is today no veneer mill in Indonesia, although most of the exported teak will be converted to veneer at its destination. In Java most wooden articles are made from teak. Practically all furniture is of solid teak. Teak is also the standard construction material, generally used in the form of timbers and assembled according to old European practices. Teak is also used for boat building and for railroad ties as well as for fuel.

The attractive grain pattern of teak wood is due in part to an annual dormant season during the summer or the dry season when teak trees shed their leaves. Some people consider the Burmese teak to be of superior quality because of a richer color contrast; however, Burmese teak supplies are on the decline and the demand for Javanese teak is growing.

The Tropical Rain Forest of East Borneo

The total productive forest area of East Borneo is about 43 million acres. These forests have been estimated to contain about 2,000 billion board feet, log scale, of merchantable timber, which is about equal to all the standing saw timber (softwoods and hardwoods) in the United States. Most of this area is now in the hands of concessionaires. Concessions are granted for periods of 20 years, initially. Trees of 20 in. DBH and larger may be cut, up to an annual average cut of about 215 board feet per acre. Meranti, a species similar to Philippine mahogany, is the principal commercial tree. This species is in great demand in today's international market. The concessionaires pay royalties and export taxes to the Indonesian government. Exportable qualities are shipped directly in log form, generally to Asian countries.

It might be interesting to examine some of the statistics of the operation of such a concession. The ITCI (International Timber Corporation Indonesia) in which Weyerhaeuser Company is a partner, may serve as an example:

Total productive area	1,000,000 acres
Merchantable timber over 20 in.BDH average 6,200 bd.ft./acre	6,200,000,000 bd.ft.
Estimated allowable annual cut 215 bd.ft/acre	215,000,000 bd.ft.
Actual cut	255,000,000 bd.ft./year
Cut over area	42,000 acres/year
Total period of first cut	appr. 24 years
Road building	
Roads required 3.4 miles/square mile	5300 miles
Cost \$13,000/mile	\$70,000,000
Rate of construction	155 miles/year

The heavy removal of timber requires regeneration by planting. This appears to be one of the problem areas. There is not enough practical field experience available in the area of regenerating tropical rain forests. Efforts are being made to build on experiences gathered in earlier similar logging operations in the Philippines and in Malaysia. In addition, it is being tried to favor certain species like Agathis, a softwood which appears to be a very desirable veneer species. Several imported fast growing pines are also being planted successfully (*pinus mercurii* and *pinus radiata*).

The concessionaires are required by contract to establish primary and secondary wood products manufacturing facilities according to a certain time table. The purpose of this requirement is to provide employment in Indonesia, to add value to timber exports and to provide needed wood products for local consumption in Java. These establishments would include sawmills, veneer and plywood mills as well as fiberboard, particleboard and paper mills. While the emphasis will be on export, these industries will be able to convert the large quantities of lesser qualities and logging waste materials to lumber and pulp products for local markets.

3. FUTURE DEVELOPMENTS

It is the official policy of the Indonesian Forest Service to increase the export of teak, particularly in the form of manufactured products like lumber, dimensions and veneer. This effort will remove substantial quantities of wood from the local markets in Java.

These losses will have to be made up by shipments from Borneo of logs, lumber and eventually manufactured products as mentioned above. Lumber and logs are now being shipped from Borneo to Java in small sailing vessels. Increase in these shipments would require considerable expansion of the fleet. These developments along with increasing demand in Java for low cost housing for the fast growing population of the larger cities will bring about changes for which the wood industry is ill prepared.

- The furniture industry is very labor intensive and uses practices which are centuries old. It will have to replace solid teak with laminated furniture panels using thin teak veneers on cores made of meranti or particleboard. These and other new methods will require machinery and other equipment which, almost always, will have to be imported from Japan, the United States or Europe. The furniture manufacturer will have to become familiar with the international machinery market. There will be a need for technicians and technologists, as well as for establishments to train them.
- The construction industry will have to abandon or modify costly and time-consuming heavy teak timber construction in favor of engineered systems using meranti from Borneo. Since meranti does not possess the natural durability of teak, facilities for the preservative treatment of wooden building components must be established. Panel materials like exterior plywood, fiberboard and resin and cement bonded particleboard should be utilized as they become available.

People in the Forest Service, in the industry and at the University are aware of these impending changes. They are frustrated by their lack of basic technology. However, they are eager to learn. I feel that the Indonesian University can contribute much by collecting, assimilating, modifying and disseminating technological information available in the world today and by establishing channels of communication between their industry and ours. Their teaching, research and public service should be oriented to serve this end.

How all these developments will affect the employment situation is difficult to predict. The creation of new industries will add jobs, the modernization of old labor intensive industries will have the opposite effect. Some officials envision new factories which will not make full use of modern mechanization and automation technology. This might be feasible in industries serving domestic markets as long as the demand exceeds the supply. In the world market, however, the plywood industry, for instance, must compete with the most advanced manufacturing facilities in Korea and Japan. This is a real dilemma and its solution is a prerequisite to an orderly development of Indonesia's resources for the benefit of her people.

FISHERY POTENTIAL IN INDONESIA

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THE COMMERCIAL FISHERY OF INDONESIA

Background

Indonesia is a nation of roughly 3,000 islands spread along the equator on the Sunda Shelf from Malaysia to Australia. These islands give rise to several protected seas such as the Java Sea, the Celebes Sea, Banda Sea and several other shallow seas. These seas are influenced by the drainage from the enclosing volcanic islands. This freshwater influx carries many nutrients thus enriching the seas with resultant high biologic productivity.

To the north lie the productive South China Sea and the Andaman Sea, and to the south the Indian Ocean. It is not surprising that a nation, set among such productive waters should rank number 10 among the nations of the world in commercial catch. This is impressive for an emerging nation, but it becomes even more noteworthy when we realize that this catch is made up mostly of near-shore fish and crustaceans.

Marine Fishery

Indonesia has about 900,000 commercial fishermen and catches annually about 800,000 metric tons of fish and shellfish. When we see that each fisherman catches only about one metric ton per year, it is evident that there is great undeveloped potential. The commercial fishery is beset by many problems which interfere with achievement of a greater potential. The gear is primitive with only 7,000 of the nearly 300,000 fishing boats motorized. The fishermen are thus restricted to fishing near shore - 10-25 miles at most. Much of the fishing is done by lift nets operated from fixed bamboo towers in shallow waters. The limited production is further hampered by limited processing, storage and transportation facilities. There is a government effort to establish a "cold chain", that is, a series of cold storage plants along routes of transportation so icing would be available at intervals to keep the fish cold during transportation.

Most of the fishermen are very small operators with little or no capital, who are unable to purchase modern gear. They are generally referred to as artisanal fishermen, and many are continually in debt to the buyer or middleman who assembles the catches of several small fishermen and trucks them to market or to another larger middleman. This situation is characteristic of many other far eastern countries. Government efforts to break this circle of continual indebtedness has had only limited success. The Indonesian Government is aware of the problem of limited productivity of its fishermen and is striving to correct the matter. Efforts to increase fisherman productivity are severely handicapped by lack of financial resources as well as lack of skilled personnel needed to show the fishermen new methods and demonstrate new gear. Efforts are being made to correct this situation, but they are painfully slow in contrast to the urgent need.

The Indonesian Government has opened the door to foreign commercial fishermen to come in and develop joint ventures with the local fishermen. This appears to be quite successful, but remains inadequate to the needs. Recently, the government has built in excellent safeguards to protect their own people. These, in brief, are: (1) Foreign interest may not exceed 49% of venture; (2) Foreign interest must be phased out in a fixed number of years, with the venture remaining in complete Indonesian ownership. The Japanese have several such joint operations and the U.S.A. has one. While this appears to be successful it is still too slow to benefit the Indonesian population so far as substantially increasing their protein food supply is concerned. It has generated considerable, much needed foreign exchange through export of high value items such as shrimp and fresh frozen fish. The volume of these exports increased 100% during the 1968-1972 period, while the value increased 1000+%. Shrimp accounted for \$28 million of the total of \$33 million of fishery exports. During this same period Indonesian fishery imports increased from \$507,000 to \$1,458,000. Imports consisted mainly of canned and fresh frozen products. These products came chiefly from Japan, Australia, Singapore, and Malaysia.

Potential for development lies in extending their fishery from inshore to offshore operations. The shallow seas should be productive for relatively small (10-20 meters) boats, with motors for propulsion and gear operation and refrigeration capability. Extension of this fishery into the offshore waters will require

a much more sophisticated program of management than is now available or is likely to be available in the near future. The capital needed to develop such a fishery is great and such a fishery has the capability of severely depleting stocks of fish unless carefully managed. If the stocks are depleted the return on the capital invested is reduced which leads to financial failure or the need for more capital to go farther afield and so on.

Indonesian educational institutions are just approaching the ability to develop the talent to carry out such management programs. This effort is impeded to some degree by the lack of appreciation of the magnitude of the problem by all parties concerned.

Some Recommendations

The joint fishing ventures could profitably be extended to include purse seining for herring-like fishes, mackeral, and tunas. With the safeguards imposed by the Indonesian Government this could be a profitable enterprise. It would require additional processing, freezing and transportation facilities.

Another approach which would benefit more Indonesian fishermen would be to carry out an educational operation with the present operators such as has been carried out by the U.S. Government and Oregon State University with the fishermen of American Samoa. This consists of a program sponsored by U.S. Government funds and involves sending a fishery scientist, a master fisherman and a master boat builder to work with the local fishermen who then are given a loan to buy materials to build a boat and nets. The boat is a 22 or 24 foot plywood outboard or inboard/outdrive motor-driven vessel capable of fishing 40 to 50 miles offshore. These boats are built like west coast fishing vessels and can be launched in the surf. They require relatively limited equipment and shore facilities and are capable of trolling for tuna and mackerel or of longlining for similar species. Very likely the average productivity per fisherman could be raised from one ton per year to 10-15 tons per year or more with such boats.

Long term, low interest loans could be arranged to include sufficient funds to clean up outstanding debts to the middlemen as well as the cost of boat, motor and modern gear. The fishermen should build all their own equipment under the guidance of the master boat builder and master fisherman so they know how to service the equipment and keep it in repair. After a few years some of these experienced persons could become boat builders, boat repairmen and motor maintenance people to serve an expanding fishery.

Inland Fishery and Aquiculture

The potential for inland pursuit fishery development is quite limited and will be dismissed with a few remarks. Freshwater pursuit fishery will be limited to reservoirs and a few larger rivers. The production capacity of such waters is quite small in contrast to the country's needs. Since they are small and scattered, management to prevent overexploitation is very difficult and usually unsuccessful.

Aquiculture in Indonesia is already a large enterprise, producing about half as much fish as the marine fishery. It is an enterprise with a long history. It is almost entirely an artisanal fishery steeped in tradition but nonetheless productive.

Aquiculture has great potential for increase through application of technical improvements in disease and parasite control, auxiliary feeding with balanced diets, and selective breeding. Currently, little is done in any of these fields. Feeding is mostly the increase of natural foods through manuring and some use of artificial fertilizers. Some use of very low value auxiliary feeding materials such as rice hulls is in practice, but this is limited and has great potential for increasing production in ponds now in use. Since carp are important fish in aquiculture here, the advances made in Israel in selective breeding for high meat to bone ratio and efficient food conversion should be adapted to Indonesia. Similar programs could be applied to species of Osteocheilus and Puntius. This would have to be done at some publicly supported experiment station and made available to the land owners.

New Species

Most of the fish grown in ponds now are used domestically. Some export of frog legs and milk fish occurs, but it is minor. Since eel larvae enter many streams in Indonesia, they could be captured and cultured to maturity in ponds for export. There is a large demand for eels in Europe and Japan. This is a high price, luxury food market and is quite lucrative. The methodology for growing eels has already been worked out in Taiwan and could be adapted to Indonesia with little difficulty.

Another species that enters rivers of Indonesia and can be cultured in ponds is the white sea bass called cacap in Indonesia. This is a high quality food fish that if filleted and frozen would find a ready market. Both Thailand and Taiwan

have grown this fish successfully in ponds using young from river mouths; both now are holding breeders in captivity and attempting to produce domestic young. In Thailand they have taken and fertilized eggs artificially with moderate success. Culture could be started with wild fry while additional research is carried out on culturing the early stages.

Several species of crustaceans have been cultured with success in Japan, Taiwan and Thailand. This technology should be borrowed and adapted in Indonesia. There has been some success in growing the freshwater shrimp Macrobrachium in ponds in Indonesia. This has great potential but needs further development. There is much research being done on this species throughout the Far East. At present, the results of these studies have been only slowly available to other countries. More support for the Indo-Pacific Fisheries Council, which tries to disseminate this kind of information, is needed. It lacks funds to publish and disseminate its publications.

Marine shrimps or prawns also offer great potential for coastal aquiculture. They are being reared commercially in Taiwan and Thailand, and this could be carried out in Indonesia as well. Some experiments have been carried out in Indonesia on rearing marine shrimp, but without knowledge of what has been done elsewhere. Shrimp is a high price food with worldwide demand and could provide appreciable foreign exchange for the country.

Perhaps the species with greatest potential is the milkfish (Chanos chanos) a herring-like fish that grows rapidly and is a plankton eater when young but becomes a detritus feeder at an early age. It can thus be grown in the same ponds with shrimp or other fish with little or no competition and no predation. It grows rapidly to marketable size of 10-11 inches in about six months. Currently they are grown in coastal ponds called "tambaks". The culture methods are well worked out and are simple. Indonesia has extensive areas in Sumatra and Irian Jaya suitable for developing coastal ponds or tambaks. The materials used for developing milkfish food are waste items such as plant residues, leaves, manures, etc., thus there is little competition for feeds used by other livestock.

These fish are bony, but are accepted by the Indonesian people. For export these fish could be deboned by machines now available and frozen in blocks for export. Markets now exist for such products in Japan, Singapore, Hong Kong, and other parts of the world. The greatest difficulty in expanding milkfish culture

is the lack of capital to clear land and make ponds. World Bank loans could probably be available for such enterprises. The government could contract to have large areas of ponds made available for sale to individuals on long term low interest financing. It has been estimated by Schuster (1949) that Indonesia has the potential for 6 million hectares of coastal fish ponds. This is a vast potential. The task of developing this potential is also vast and will require all the capital that can be made available for years. Perhaps more difficult than getting capital will be obtaining persons with an entrepreneurship and knowledge needed to manage and operate these facilities. It will be a challenge to the educational institutions to produce graduates capable of initiating and carrying out such a program.

The officials in charge of the Department of Fisheries are aware of all these problems and conditions and are doing very well at trying to get many of these projects underway. The difficulties are formidable and Indonesia needs all the help and encouragement it can get. However, it is doubtful if more advice is needed. What is needed is technical know-how that can be directly translated into operations on boats, ponds, in markets, processing plants and transportation enterprises.

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PLANTATION AGRICULTURE - NEW HORIZONS FOR RUBBER*

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Many of you know that rubber is the largest agricultural export from Indonesia and the third in line after oil and timber. I'd like to start out this very brief presentation this afternoon by spelling out what I consider to be the most significant developments that have taken place in natural rubber. The first one is that during the last eight years we have had a scientific revolution in natural rubber, which is really, in my opinion at least, among the great events of our time. This is a scientific revolution which has meant that whereas eight years ago we assumed that natural rubber was doomed (that synthetic rubber would take over and the growers of natural rubber were going to be the poor people of the world), almost the reverse is now taking place. Secondly, I would submit that this achievement is largely to the credit of the Rubber Research Institute of Malaya, now the Rubber Research Institute of Malaysia. This is, incidentally, the largest research institute in the world devoted to a single crop product. It is located in Kuala Lumpur, the capital of Malaysia, and has its research stations outside of Kuala Lumpur. One of its stations alone covers 3,500 acres. To me it offers evidence of what can be accomplished when you mobilize all of the first class talent that you can put to work on a job, give them clear-cut assignments, insure that they have adequate funding, and give them freedom from political interference in staffing and the rest. And next I would submit that what has actually happened with natural rubber has changed the economic prospects for Indonesia and other rubber producing countries, as well as Malaysia. Indonesia is the second largest producer of natural rubber in the world, followed by Thailand and Sri Lanka, the Khmer Republic and to some extent Viet Nam and the other countries that are growing rubber. For what we have seen here is a product of this scientific

* For a more detailed discussion and illustrated views of this topic, see Dr. Ravenholt's article Natural Rubber's New Horizons, in Southeast Asia Series, Vol. XVIII No. 12 Malaysia, American Universities Fieldstaff Reports, A.U.F.S., Hanover, N.H. 03755

revolution, a major transformation in the economic future for small farmers, for a significant portion of rubber production comes from farmers in these countries. And finally, I would submit that what we have here also is a demonstration of how an exhaustible resource, and in fact a resource being exhausted, can be supplemented, or can be actually now replaced by a renewable resource. In other words, when we're thinking of synthetic rubber we are thinking in terms of a resource which we all know is based on crude petroleum, ultimately, and which is not going to be with us indefinitely in this world. But when we're talking about natural rubber, we're talking about something that can be grown, and as you will see, can be grown in larger and larger quantities.

Thus, let's go back very briefly and consider how this came about. In essence, what happened is that wild rubber (*Hevea brasiliensis*) plants which were carried from Brazil to the Kew Gardens of London, thence to the Singapore Botanical Gardens, and ultimately from there to Malaya, Indonesia, and so forth, came at the right time in the history of the world. This was the end of the nineteenth, the beginning of the twentieth century. This was the time when industrialization, and people like Henry Ford, and all the things that you do here in Lansing and for which Michigan and Detroit are famous, were getting started. Thus the natural rubber industry got on its feet at just the right time in Southeast Asia. And the reason why rubber production is located in Southeast Asia and not in Latin America, of course, is because of the leaf blight disease. You can not grow natural rubber on a plantation scale in the New World at this stage. We do not have the technology to control the leaf blight which is indigenous to the area. And, as some of you may know, there are very strict regulations that inhibit people traveling directly from South America to Southeast Asia. I am frankly puzzled myself sometimes as to why the leaf blight hasn't gotten into West Africa, with the direct airline connections between South America and West Africa. So, the plantation rubber developed in Southeast Asia, and I must say that it was a boom business in the period of the first World War. Then you had the depression that followed the first World War, still rubber fluctuated, almost as elastic in fact in price as it was in performance. This was followed by the Great Depression, and you had an attempt to hold prices up by curtailment of production and export by the British, the Dutch, the French and the other colonial powers involved. In many ways this policy was abortive, and incidentally one which resulted in the vast expansion of

small-holder rubber, especially in Indonesia. In other words, the biggest states had agreed they would curtail production, but the small-holders expanded their plantings. And so they tried another scheme, which was an attempt to control the export of rubber. In 1941-42 the Japanese took Southeast Asia, and suddenly the Allies were confronted with the necessity of developing in a major way the synthetic rubber that was needed in the economies of Britain, Canada, the United States, etc. And from this came the immense construction of synthetic rubber plants in the western world, as well as those that had been built earlier in Germany, and of course the Russians had built their own as well going even further back.

Now this meant that natural rubber emerged out of World War II with a very difficult prospect, one compounded in the case of Malaysia by the insurgency situation and, as we all know, in the case of Indonesia by the difficulties that have beset the Republic of Indonesia over the last two and one-half decades.

Now let's turn our attention to what has really happened scientifically in natural rubber, and at the Rubber Research Institute of Malaya. I'll make the presentation very brief. There have been five major developments there. Let me say first emphatically the Rubber Research Institute of Malaya is supported by the Rubber Fund Board. The Rubber Fund Board receives its revenue from a cess or export tax on every pound of rubber that leaves Malaya, and I believe it has been extended to East Malaysia which would make it every pound of rubber that leaves Malaysia. Now this cess, or tax, goes to the Rubber Fund Board, which divides the money between the efforts at market research which are centered principally in London, and the Rubber Research Institute of Malaya, which is centered in Kuala Lumpur and at experiment stations outside. And it is with these resources that Dr. B.C. Sekhar, who is director of the Institute and incidentally the first Malaysian of Indian ancestry (his father was the assistant manager of a rubber estate about 15 miles from where the Institute's research station is located today), and his associates have moved forward. The first development, for which we must give them credit, is that of a set of technical grading specifications and regulations. Formerly, natural rubber was exported abroad and it was graded on sight and feel. But the bareback bale, incidentally weighing about 250 pounds, was the size of the old chests of tea that were exported from Asia to Europe in the early years of contact. Now, the new system of grading, known as SMR in Malaysia (standard Malaysian rubber) and more recently, SIR (standard Indonesian rubber) is grading to

technical specifications for plasticity retention index and other physical and chemical characteristics in the rubber. So the buyer of rubber at the other end, whether he be in Western Europe, Japan, or the United States, knows what he's going to get. This was not formerly true, as I recall from a talk I had with a U.S. manufacturer one day. As I was travelling to Madison, I think it was, from St. Paul, I was talking with a manufacturer of tennis shoes and I said, "Why don't you buy natural rubber?" He said, "I never can be sure of what I'm getting." This was before the days of technical grading.

The next thing has been the development of the Heveacrumb process, which is a new method of manufacturing rubber. Under the old system of manufacturing rubber, what happened was that you would coagulate your latex, squeeze most of the water out of the latex and produce a rip sheet and then hang up your rip sheet and smoke it for five to seven days in a smokehouse. And from that you produced your rip smoke sheet - the RSS, and you know the grades that went with RSS. Now under the new system, the Heveacrumb, the latex is coagulated, you add a bit of castor oil to insure against it being one solid mass, and the latex which may arrive at the factory at noon comes out at the end of the day in 75-80 pound blocks wrapped in polyethylene. These blocks are then piled on pallets and they're exported in half-ton or one-ton pallets. And so when it gets to the consumer in Europe or wherever it may be, he takes this block of Heveacrumb rubber and tosses it into the Banbury mixer where other ingredients are added for specific products. It doesn't have to go through the guillotine as was the case with the bareback bale. That's the second important development, the Heveacrumb factory for making rubber out of latex.

The third major development is a botanical development. This is the development of new, vastly improved varieties of rubber, and the program of budding or using one clone for the root, one clone for the trunk, and sometimes a third clone for the crown of a tree, for wind and disease resistance and to increase the yield of latex.

The fourth development, and this is also an interesting one, is a new system of tapping. You put styrofoam around the tree, and then you tap it in a plastic bag instead of a coconut shell or a cup; thereby you have no water or dirt in the latex. And you can collect every two weeks if you want to, provided somebody else doesn't collect your plastic bags, which is incidentally a small problem. This

new technique vastly simplifies the task of collecting your rubber and all that goes with it.

And finally, the fifth major development is one I was just discussing at Cal Tech with Dr. Jim Bonner, the molecular biologist who was one of the men who helped in the development of another new idea. This involves the utilization of an ethylene product that you paint on the tree below the tapping cut. It is called an anti-coagulant yield stimulant. What in effect this anti-coagulant yield stimulant does is to allow the rubber tree to produce far more latex than it did formerly. Let me give you an example.

On a control plot of RRIM 600, which is one of the better, longer established varieties of rubber in Malaysia, they were getting on 12 year trees about 2,200 pounds per acre per year of rubber. Using the anti-coagulant yield stimulant, they got approximately 5,400 pounds of rubber per acre per year. Now 5,400 pounds of rubber per acre per year, at today's prices of rubber (I think it's about U.S. 54¢ a pound) is a lot of money. I think you begin to see that what we're talking about is a scientific revolution which has turned around the future for natural rubber producers in the world.

Now, mind you, getting all of this knowledge and new inputs to the estate owner, the estates, and the small-holder farmer or producer is going to take work. However, I would say that in Malaysia they have made very good headway, and I noted also in the areas I visited in Sumatra that rubber producers are rapidly catching up. The economics of the Heveacrumb process, the advantages in marketing, and the potentiality of the anti-coagulant yield stimulants as they become available, are immense. What really exists now is the opportunity for the natural rubber industry not only to save itself, but also to become a thoroughly profitable form of farming for the moist tropics of Southeast Asia. I should add one other fact to this which is worth keeping in mind, and that is, the Arabs in the past year have further enhanced the potentialities of natural rubber. What they have done is to push the price of crude petroleum to a level today where, on a price basis, synthetic rubber cannot compete with the cost of production of natural rubber using the new technology.